Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

Sex Transm Dis. Author manuscript; available in PMC 2025 May 01.

Published in final edited form as:

Sex Transm Dis. 2024 May 01; 51(5): 313–319. doi:10.1097/OLQ.0000000000001930.

Treatment Rates for Chlamydia trachomatis (CT) and Neisseria gonorrhoeae (GC) in a Metropolitan Area: Observational Cohort Analysis

Brian E Dixon, PhD, MPA[1,2], **John Price, MA**[2], **Nimish R Valvi, DrPH**[3], **Katie S. Allen, BS**[1,2], **Christine L Heumann, MD, MPH**[4], **Melissa K Titus, MPH**[1], **Thomas J Duszynski, PhD, MPH**[1], **Ashley Wiensch, MPH**[2], **Guoyu Tao, PhD**[5]

[1]Fairbanks School of Public Health, Indiana University, Indianapolis, IN;

[2]Center for Biomedical Informatics, Regenstrief Institute, Indianapolis, IN;

[3]Ball State University, Muncie, IN;

[4]Indiana University School of Medicine, Indianapolis, IN;

[5]Centers for Disease Control and Prevention, Atlanta, GA.

Abstract

Background: Chlamydia trachomatis (CT) and Neisseria gonorrhoeae (GC) are the two most common sexually transmitted infections in the United States (US). The Centers for Disease Control and Prevention (CDC) regularly publishes and updates Sexually Transmitted Infection (STI) Treatment Guidelines. The purpose of this study is to measure and compare treatment rates for CT and GC among public and private providers.

Methods: Data from multiple sources, including electronic health records (EHRs) and Medicaid claims, were linked and integrated. Cases observed during 2016–2020 were defined based on positive laboratory results. We calculated descriptive statistics and odd ratios based on characteristics of providers and patients, stratifying by public versus private providers. Univariate logistic regression models were used to examine the factors associated with recommended treatment.

Results: Overall, we found that 82.2% and 63.0% of initial CT and GC episodes, respectively, received CDC-recommended treatment. The public STI clinic treated over 90% of CT and GC cases consistently across the 5-year time period. Private providers were significantly less likely to treat first episodes for CT (79.6%) and GC (53.3%), $p<0.01$. Other factors associated with higher likelihood of recommended treatment included being male, being HIV positive, and identifying as Black or multi-racial. Among GC cases, 10.8% received non-recommended treatment; all CT cases with treatment occurred per guidelines.

Corresponding Author: Brian Dixon, 1101 W. 10th St., Indianapolis, IN, 46202, Phone: 317-278-3072, bedixon@regenstrief.org.

Conflicts of Interest: None of the authors have any conflicts of interest to disclose.

Disclaimer: The findings and conclusions in this study are those of the authors and do not necessarily represent views of the Centers for Disease Control and Prevention.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Conclusions: Although these treatment rates are higher than previous studies, there remain significant gaps in STI treatment that require intervention from public health.

SHORT SUMMARY

A retrospective study of linked data from a metropolitan area found the majority of STI cases received CDC-recommended treatment, yet private providers were significantly less likely to treat index cases.

Keywords

Chlamydia trachomatis; Neisseria gonorrhoeae; electronic health records; guideline adherence

INTRODUCTION

Chlamydia trachomatis (CT) and Neisseria gonorrhoeae (GC) are the two most frequently reported sexually transmitted infections (STIs) in the United States. In 2021, these infections impacted nearly 2.4 million Americans.(1) In addition, there has been a steady increase in sexually transmitted infections in the United States, even with disruptions related to a global pandemic. GC alone was up an estimated 10% in 2020 over 2019.(2) Both CT and GC are largely asymptomatic until complications occur, relying on screening tests for diagnosis and treatment(2, 3) to prevent long-term comorbidities. Given the long-term consequences of undiagnosed STIs such as infertility and chronic pain, increasing CT and GC rates constitute a significant threat to public health.

Effective and timely treatment can prevent adverse reproductive health complications and sexual transmission.(4) Treatment decisions are dependent on the individual clinician, which presents the potential for variability across care settings and patient populations. Therefore, the U.S. Centers for Disease Control and Prevention (CDC) publishes and regularly updates STI treatment guidelines(5) which influence clinical decision-making surrounding treatment and advise the circumstances in which presumptive treatment should be provided to patients. The guidelines further help providers utilize antimicrobials that reduce resistance, ensuring effective treatment of STIs.(4) However, adherence to the guidelines is still at the discretion of the clinician, which could lead to variation in treatment rates. Specifically, there may be differences between public health clinics, especially STI specialty clinics, (aka public providers) and private health care settings (aka private providers) such as independent or private physician offices, non-profit health care systems, and for-profit health care systems.

The evidence base for CT and GC treatment rates has grown over the past decade and includes analyses among public and private providers. There is a persistent trend of overall high adherence to treatment recommendations for both CT and GC across public clinical settings but lower adherence to treatment recommendations in private settings.(4, 6–12) Additionally, there is variability in presumptive treatment as well as over- and undertreatment of CT and GC.(13) Furthermore, many studies examined data from a single or small group of health systems.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

The purpose of this study is to measure and compare CT and GC treatment rates, as well as adherence to CDC-recommended treatments, across a metropolitan region using data from multiple sources and dozens of health systems. This study utilizes data from public and private providers to examine treatment of STIs comprehensively. To facilitate a population-based approach, we used a linked dataset that included case management files from the state health department, Medicaid claims, and electronic health records (EHRs) from a regional health information exchange (HIE) network.

MATERIALS and METHODS

Study design

We performed a retrospective cross-sectional analysis for individuals aged 15–60 diagnosed with CT or GC between January 1, 2016 and December 31, 2020 and who lived in the Indianapolis metropolitan area. This geographical area includes 9 counties which represent Health Region 5 within the Indiana Department of Health (IDOH). The region is served by a single public STI clinic located in downtown Indianapolis, operated by Eskenazi Health and the Marion County Public Health Department.

Data sources

To capture complete data on STI cases and treatment, we merged information from four distinct electronic sources. The main source was the IDOH case management system (NEDSS Base System or NBS), which contains all CT and GC cases reported to IDOH under Indiana communicable disease regulations. Cases are reported using multiple methods, including electronic laboratory reporting from providers and faxed case reports from providers to local health departments. Surveillance cases are reviewed and confirmed by disease investigation specialists (DIS) at IDOH and local health departments. The DIS attempt to confirm via phone, fax, and secure messaging whether treatment was offered to the patient. In some cases, treatment is documented on case reports received from providers or found through lookups in the EHR system in counties where DIS staff have direct access to medical records.

The second source is the Indiana Network for Patient Care (INPC), an HIE network that contains EHR data captured from over 103 Indiana hospitals and 60 community clinics.(14) The HIE network is used frequently for public health surveillance and research,(15–17) including STI studies. Cases were defined based on the presence of a positive laboratory test for CT or GC. The INPC further includes medication orders, which document prescription of treatment by a provider even if the patient never fills or completes treatment.

The third source was the EHR database for the Bellflower Clinic, the public STI clinic for the metropolitan area. Cases were defined based on a positive laboratory result for CT or GC. This source also documents medication orders from providers.

The final source was the Family and Social Services Administration (FSSA) claims database, which contains Medicaid claims for individuals living in Indiana. Medicaid claims were not used to identify cases but provided information on treatment for individuals who tested positive for CT or GC.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Data linkage was performed by the Management Performance Hub (MPH), a division of the Indiana State Government.(18) A unique identifier was created to link data from the four sources for each patient, and all records were deidentified before release to the researchers. The final set of cases included testing and treatment data from at least one source. Cases could also have data from multiple sources, including laboratory testing data from one source (e.g., EHR) but treatment data from another source (e.g., Medicaid claims).

The dataset included information on the following variables: age, sex, race, ethnicity, disease, test date, laboratory test result date, medication (if treated), and county of residence. We further classified age in the following categories in years (15 to 24, 25 to 34, 35 to 44, and 45 to 60).

Laboratory Test Results

From sources that contained laboratory test results, we selected all tests conducted for CT or GC. We excluded tests that were indeterminate or had missing information. For each individual, we selected their first chlamydia or gonorrhea test for the observed time period and classified them as either positive or negative for either chlamydia or gonorrhea. Positive cases are also referred to as “first episodes” and represent the first infection observed during the study period to distinguish from subsequent tests and re-infections, which were excluded.

Chlamydia and Gonorrhea Treatment

Available medication information was extracted from all four sources and merged into the final dataset. Treatment status was assessed based on receipt of treatment regimen within 30 days from the laboratory test date. Treatments were classified as either “recommended” or “other” based on the 2015 edition of the CDC Sexually Transmitted Diseases Treatment Guidelines.(19) Recommended treatment for lab-positive CT individuals was doxycycline 100 mg orally twice a day for 7 days, azithromycin 1 gm in a single dose, or azithromycin 2 gm orally in a single dose. We also identified alternative recommended regimens like levofloxacin 500 mg orally once daily, erythromycin 500 or 800 mg orally four times a day for 7 days, erythromycin 250 or 400 mg orally four times a day for 14 days, or amoxicillin 500 mg orally thrice a day for 7 days. For lab-positive GC, recommended treatment was considered based on receiving ceftriaxone 250 mg intramuscularly in a single dose plus azithromycin 1 g orally in a single dose, ceftriaxone 250 mg intramuscularly in a single dose plus doxycycline 100 mg orally twice daily for 7 days, or ceftriaxone 1 g plus azithromycin 1 g orally in a single dose. The recommended alternative regimens were cefixime 400 mg in a single dose plus azithromycin 1 g orally in a single dose or gentamicin 240 mg intramuscularly in a single dose plus azithromycin 2 g orally in a single dose. All other treatments were classified as a non-recommended treatment based on manual review by an epidemiologist with over a decade of experience working with STI. We did not observe the presence of any non-recommended treatments among CT cases; all cases were either treated or untreated. Among GC cases, we observed around 10% of cases involved non-recommended treatment. Non-adherent treatment predominantly involved treatment using only azithromycin, ceftriaxone, or doxycycline.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Data analysis

Descriptive statistics were calculated based on cohort characteristics and treatments for each disease. Results were stratified by cases diagnosed in public vs. private settings. Patients seen at the public STI clinic were classified as public provider cases. All other cases were classified as private provider cases. We further assessed the factors associated with recommended treatment using univariate logistic regression models where recommended treatment was compared to a reference group of those without treatment. Results are presented as odds ratios (ORs) and 95% confidence intervals (CIs) and $P < .05$ was considered statistically significant. All analyses were performed using R Version 3.6.3. The study received approval by the Institutional Review Board at Indiana University (Protocol No. 13233).

RESULTS

After linking and merging data, we identified a total of 52,946 CT cases and 25,699 GC cases representing first episodes diagnosed from 2016 thru 2020 across the metropolitan area. Figure 1 represents the flow of data from the individual sources into a set of linked CT and GC cases for analysis. Of these cases, 43,144 (81.5%) CT cases and 19,421 (75.6%) GC cases came from private providers, respectively. A similar number of cases (mean 5,140) were reported each year for GC; however, we observed decreasing first episodes (mean 10,589) for CT over the same timeframe.

Table 1 summarizes overall CT and GC case characteristics as well as recommended treatment rates. Overall, 82.2% and 73.8% of first episode CT and GC cases, respectively, were treated. All treated CT cases received a recommended treatment based on CDC guidelines. For GC, 63% of first episodes received a recommended treatment and 10.8% of first episodes received a non-recommended treatment. Among GC cases involving non-recommended treatment, 38% involved treatment using only azithromycin, 34% were treated using only ceftriaxone, and 14% were treated using only doxycycline. A total of 10 patients were treated with Gepotidacin and Zoliflodacin, experimental treatments for GC.

Public providers treated over 90% of CT and GC first episodes seen at the public STI clinic. Moreover, cases at the public STI clinic received recommended treatment for all CT cases and 94% of GC cases. Private providers treated 79.6% and 67.1% of CT and GC first episodes, respectively, diagnosed in private settings. Private providers offered recommended treatment 53.3% of the time for GC cases; all treated CT cases received recommended treatment. The proportion of total cases treated using a recommended treatment fell over time for both CT and GC, driven by declines in treatment among private providers (see Figure 2).

Tables 2 and 3 summarize the factors associated with recommended treatment for CT and GC respectively. Factors were similar for both diseases. First episodes diagnosed in private settings were significantly less likely to receive recommended treatment (OR, 0.26, 95% CI: 0.24, 0.29)] and [OR, 0.10, 95% CI: 0.09, 0.11, p<0.01)] for CT and GC, respectively. Older patients were significantly less likely to receive recommended treatment for CT (45–60 years, OR, 0.82, 95% CI: 0.72, 0.94 p<0.01) and GC (25–34 years, OR, 0.82, 95% CI:

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

0.76, 0.88, p<0.01; 35–44 years, OR, 0.05, p<0.01; 45–60 years, OR, 0.14, 95% CI: 0.13, 0.17, p<0.01) compared to 15–24-year-olds. Male patients were significantly more likely to receive recommended treatment (OR, 1.16, 95% CI: 1.10, 1.21 and OR, 1.42, 95% CI: 1.34, 1.50, p<0.01) compared to females for CT and GC, respectively. Individuals with HIV were significantly more likely to receive recommended treatment (OR, 1.47, 95% CI: 1.22, 1.78 and OR, 1.87, 95% CI: 1.59, 2.20), p<0.01) for CT and GC respectively. Black and other minority racial groups were significantly more likely to receive recommended compared to white patients for CT and GC treatment (OR, 1.41, 95% CI: 1.34, 1.48 and OR, 3.50, 95% CI: 3.29, 3.72, p<0.01 respectively). Hispanic patients were significantly more likely to receive recommended treatment for GC (OR, 1.16, 95% CI: 1.01, 1.33, p=0.03) but not for CT (OR, 1.01, 95% CI: 0.93, 1.10, p=0.84).

Of the 17,175 GC cases, 5,747 (33.5%) were concurrently infected with CT during the same 30-day window. Among these dual GC/CT cases, 4,633 (80.6%) received recommended treatment. Being co-infected was associated with higher odds of receiving recommended treatment (OR 2.02, p<0.01) compared to individuals without a co-infection of CT.

Figure 2 shows recommended treatment rates for CT and GC by year during the observation period, stratified by provider setting. The public STI clinic consistently treated >90% of cases of CT and GC with CDC-recommended treatments over time. Recommended treatment for CT declined from >95% in 2016 to just above 90% in 2020 at the public STI clinic. Private providers consistently decreased their use of CDC-recommended treatments over time for both CT and GC. Recommended treatment for CT declined from around 85% in 2016 to just above 60% in 2020. Recommended treatment for GC declined from around 57% in 2016 to below 50% in 2020.

DISCUSSION

In a comprehensive analysis of STI cases, representing the first episode of disease within the observed time period, we found that 82% and 63% of cases receive CDC-recommended treatment for CT and GC, respectively. Moreover, treatment rates for first episodes declined over time among private providers with the public health STI clinic treating over 90% of cases consistently from 2016–2020. These results are encouraging as most patients received treatments recommended in CDC guidelines. However, the findings highlight the need for more work to encourage private providers to use recommended treatments in addressing America’s rising rates of STIs.

These findings are consistent with past research. Several studies have demonstrated overall high treatment rates for both CT and GC.(6–10, 12, 20) However, those that evaluated private clinical settings found lower results overall, especially when compared to a public counterpart.(8, 10, 20) Importantly, a study leveraging commercial data from 2016–2018 showed a much lower than the CDC-recommended rate for chlamydia (34.8%) and gonorrhea (64.2%) among private providers.[10] A scoping review covering 2006 – 2021 identified wide variation in rates of presumptive treatment as well as over- and undertreatment of GC and CT.(13) This variation persisted across care settings, patient characteristics, and geographic location. An additional finding of this scoping review is

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

that many studies relied on data extracted from a single or small group of health systems. Therefore, while our findings are consistent with prior studies, this study employed a more robust method for data capture and analysis at a geographic regional level. It further enabled analysis of treatment rates over time.

In our study, with respect to overall treatment, nearly 1-in-5 patients with CT and 1-in-4 patients with GC went untreated. Given that these were first episodes, meaning the first case diagnosed in the 5-year time window, it is concerning that providers, especially those in private health care settings, did not appear to treat patients. Untreated cases may result in disease spread as well as morbidity, likely contributing to nationally rising rates of both diseases. Yet these results do reveal higher levels of treatment compared to a CDC analysis of commercial claims data performed on data during a similar timeframe.(7) By incorporating medication orders from EHRs and medication claims data from Medicaid, we identified more evidence of treatment even though we also identified additional cases of STIs through EHR-based laboratory data (i.e., we found cases not documented in the surveillance system). Therefore, the overall gap between those who did or did not receive treatment is lower than previously estimated.

Patients visiting public STI clinics, males, younger patients, minority populations, those living with HIV, and those co-infected with GC and CT were more likely to receive recommended treatment compared to those untreated. It is likely these factors have some correlations as the public STI clinic's population is majority Black (50%-60%) and Hispanic (10%-20%) as well as male (60%). Lower treatment rates among private providers compared to public providers aligns with prior studies that also examined these two groups. Like several prior studies,(7, 8, 10, 20) we found that private providers were significantly less likely to use CDC-recommended treatments. We also found that men were more likely than women to receive recommended treatments, likely due to a high male population at the public health clinic. Moreover, public health outreach efforts aimed at MSM populations at higher risk for STIs(21–24) likely contribute to higher rates of screening and treatment among men. Individuals who living with HIV and those with dual GC/CT infections were also more likely to receive recommended treatments. Individuals living with HIV are likely seeking treatment from infectious disease providers who are more likely to be aware of STI treatment guidelines.

Treatment rates declined after 2018, with a significant decrease among private providers (Figure 2). This decline may be attributable to the identification and reporting of combined ceftriaxone resistance and high-level azithromycin resistance among GC cases in the UK and Australia, which prompted discussion and expert panels in the U.S. in 2018.(25) The CDC Gonococcal Isolate Surveillance Project (GISP) found reduced ceftriaxone susceptibility and increasing azithromycin resistance from 2014–2017.(26) There is growing awareness of antimicrobial resistance as a public health crisis in recent years following reports and an action plan from the World Health Organization.(27) Armed with information about resistance, providers may choose to avoid specific antibiotics found to have some level of resistance. Reflexive clinical decision support prompts in the EHR could remind providers that treatment with just one type of antibiotic may not be sufficient per CDC treatment guidelines. In addition, public health may need to utilize more frequent, updated

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

guidelines, potentially aided by EHR decision support algorithms, to better support timely treatment of STIs while changing regimens to address antibiotic resistance.

We did not distinguish between outpatient, emergency department, and inpatient settings. Therefore, it is not clear from these data which providers might be targeted for education or interventions to improve treatment rates. More closely examining treatment rates by specific providers (e.g., health system, hospital, clinic) may yield insights for a jurisdiction that seeks to improve use of recommended treatment among private providers. Moreover, the most recent CDC guidelines were updated in 2021. Future analyses should re-assess treatment rates based on the updated guidelines.

We also note that the methods used in this analysis support CDC's Data Modernization Initiative,(28) which calls for upgrading the nation's surveillance systems using electronic data sources. We incorporated Medicaid claims data as well as EHR data from multiple sources leveraging a statewide HIE network. Operationalizing multi-source data streams for surveillance and response to disease burden in the community is a goal for many jurisdictions that are working to implement DMI strategies. In our case, we leveraged a public sector enhanced research environment (ERE) that expedites research and analysis by bringing research teams from multiple agencies and the private sector as well as code and data together. Public-private partnerships and infrastructure like those used in this project could be used by other jurisdictions to catalyze efforts to address high priority public health challenges such as STI burden.

This project has limitations to note. First, case linkage algorithms employed by the Management Performance Hub are not perfect. Therefore, the dataset may contain duplicate cases that inflate or conflate treatment rates. However, we hope this is mitigated by the high level of cases available for analysis. Second, the HIE network included medications ordered by providers. The treatment data therefore do not guarantee the patient filled the prescription and completed treatment as recommended by their provider. Third, despite the comprehensive approach used to systematically capture treatment data from multiple sources, some cases may have been treated but without appropriate documentation in the EHR or an insurance claim. This would lead to underestimates of STI treatment.

Conclusion

This study provides comprehensive evidence on the treatment of CT and GC in a large metropolitan area. Although treatment rates are high among public STI settings, private providers do not treat STIs at similar rates and treatment rates among private providers are declining. Furthermore, some populations are more likely to receive treatment than others. Given a marked increase in CT and GC burden, there remains much work for public health to do in support of treating STI cases among all affected populations.

Acknowledgements

This study was funded by the Centers for Disease Control and Prevention Contract # 75D30121P12703. The authors further acknowledge the assistance of employees at the Indiana MPH (Management Performance Hub) in linking and merging data from the multiple sources. We further appreciate the support and assistance in accessing data from the Bell Flower Clinic at the Marion County Public Health Department and Eskenazi Health as well as

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

the Medicaid data from the Indiana Family Social Services Administration. Finally, we acknowledge support in data from the Indiana Network for Patient Care (INPC) by data analysts and scientists at the Regenstrief Institute.

References

1. Centers for Disease Control and Prevention 2021;Pages. Accessed at https://www.cdc.gov/std/statistics/2021/default.htm. Accessed Apr 11 2023.
2. Workowski KA, Bachmann LH, Chan PA, et al. Sexually Transmitted Infections Treatment Guidelines, 2021. MMWR Recomm Rep. 2021;70(4):1–187.
3. Dukers-Muijrers N, Evers YJ, Hoebe C, et al. Controversies and evidence on Chlamydia testing and treatment in asymptomatic women and men who have sex with men: a narrative review. BMC Infect Dis. 2022;22(1):255. [PubMed: 35287617]
4. Workowski KA, Bolan GA. Sexually transmitted diseases treatment guidelines, 2015. MMWR Recomm Rep. 2015;64(Rr-03):1–137.
5. Centers for Disease Control and Prevention 2021;Pages. Accessed at https://www.cdc.gov/std/treatment-guidelines/default.htm. Accessed Oct 31 2023.
6. McWhirter L, Lou Y, Reingold S, et al. Rates of Appropriate Treatment and Follow-Up Testing After a Gonorrhea and/or Chlamydia Infection in an Urban Network of Federally Qualified Health Center Systems. Sex Transm Dis. 2022;49(5):319–24. [PubMed: 35001017]
7. Tao G, Workowski K, Bowden KE, et al. Estimating Recommended Gonorrhea and Chlamydia Treatment Rate Using Linked Medical Claims, Prescription, and Laboratory Data in US Private Settings. Sex Transm Dis. 2021;48(3):167–73. [PubMed: 33003184]
8. Weston EJ, Workowski K, Torrone E, et al. Adherence to CDC Recommendations for the Treatment of Uncomplicated Gonorrhea - STD Surveillance Network, United States, 2016. MMWR Morb Mortal Wkly Rep. 2018;67(16):473–6. [PubMed: 29698384]
9. Wilson SP, Vohra T, Knych M, et al. Gonorrhea and chlamydia in the emergency department: Continued need for more focused treatment for men, women and pregnant women. Am J Emerg Med. 2017;35(5):701–3. [PubMed: 28073612]
10. Lechtenberg RJ, Samuel MC, Bernstein KT, et al. Variation in adherence to the treatment guidelines for Neisseria gonorrhoeae by clinical practice setting, California, 2009 to 2011. Sex Transm Dis. 2014;41(5):338–44. [PubMed: 24722391]
11. Peterman TA, Newman DR, Collins DE, et al. Sexually transmitted diseases program performance measures: how are they performing? Sex Transm Dis. 2011;38(7):610–6. [PubMed: 21278623]
12. Kovaleski L, Feldman C, Baker S, et al. Gaps in Chlamydia Treatment Within California Family Planning Clinics: Are Patients Filling Prescriptions? Sex Transm Dis. 2019;46(6):370–4. [PubMed: 30817496]
13. Allen KS, Hinrichs R, Heumann CL, et al. Findings From a Scoping Review: Presumptive Treatment for Chlamydiatrachomatis and Neisseria gonorrhoeae in the United States, 2006–2021. Sexually Transmitted Diseases. 2023;50(4):209–14. [PubMed: 36584164]
14. Overhage JM, Kansky JP. Chapter 22 - The Indiana Health Information Exchange. In: Dixon BE, ed. Health Information Exchange (Second Edition): Academic Press; 2023:471–87.
15. Dixon BE, Whipple EC, Lajiness JM, Murray MD. Utilizing an integrated infrastructure for outcomes research: a systematic review. Health Info Libr J. 2016;33(1):7–32. [PubMed: 26639793]
16. Ho YA, Allen K, Tao G, et al. Provider Adherence to Syphilis Testing Guidelines Among Stillbirth Cases. Sex Transm Dis. 2020;47(10):686–90. [PubMed: 32936603]
17. Ojo OC, Arno JN, Tao G, et al. Syphilis testing adherence among women with livebirth deliveries: Indianapolis 2014–2016. BMC Pregnancy Childbirth. 2021;21(1):739. [PubMed: 34717575]
18. State of Indiana 2023;Pages. Accessed at https://www.in.gov/mph/. Accessed Nov 1 2023.
19. Centers for Disease Control and Prevention 2015;Pages. Accessed at https://www.cdc.gov/std/tg2015/. Accessed November 8 2016.
20. Tabidze IL, Nicholson TF, Mikati T, et al. Adherence to Centers for Disease Control and Prevention Gonococcal Treatment Guidelines Among Chicago Health Care Providers, 2011–2012. Sex Transm Dis. 2015;42(8):422–8. [PubMed: 26165433]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

21. Bosetti D, Mugglin C, Calmy A, et al. Risk Factors and Incidence of Sexually Transmitted Infections in the Swiss HIV Cohort Study. Open Forum Infect Dis. 2022;9(12):ofac592.
22. Chemtob D, Mor Z, Harel N, Averick N. HIV infection among men who have sex with men in Israel: a 35-year epidemiological and clinical overview, 1981–2015. BMC Public Health. 2019;19(1):747. [PubMed: 31196014]
23. Figueroa JP, Cooper CJ, Edwards JK, et al. Understanding the high prevalence of HIV and other sexually transmitted infections among socio-economically vulnerable men who have sex with men in Jamaica. PLoS One. 2015;10(2):e0117686. [PubMed: 25659122]
24. Beyrer C, Baral SD, Walker D, et al. The expanding epidemics of HIV type 1 among men who have sex with men in low- and middle-income countries: diversity and consistency. Epidemiol Rev. 2010;32:137–51. [PubMed: 20573756]
25. Seña AC, Bachmann L, Johnston C, et al. Optimising treatments for sexually transmitted infections: surveillance, pharmacokinetics and pharmacodynamics, therapeutic strategies, and molecular resistance prediction. Lancet Infect Dis. 2020;20(8):e181–e91. [PubMed: 32569625]
26. Centers for Disease Control and Prevention;Pages. Accessed at https://www.cdc.gov/std/gisp/default.htm. Accessed Nov 1 2023.
27. Alirol E, Wi TE, Bala M, et al. Multidrug-resistant gonorrhea: A research and development roadmap to discover new medicines. PLoS Med. 2017;14(7):e1002366. [PubMed: 28746372]
28. Centers for Disease Control and Prevention 2023;Pages. Accessed at https://www.cdc.gov/surveillance/surveillance-data-strategies/data-IT-transformation.html. Accessed Nov 1 2023.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

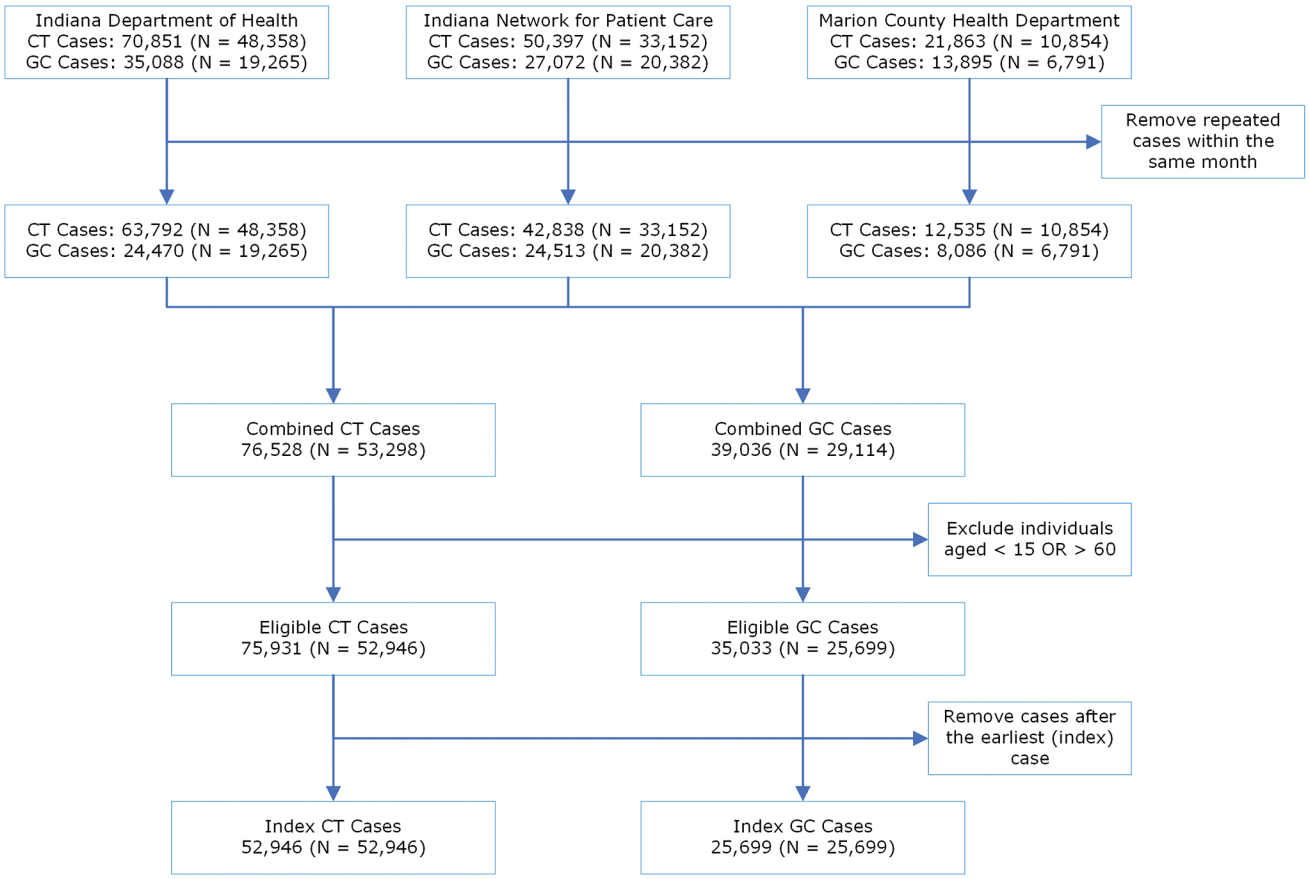

Figure 1.

Flowchart showing the capture, linking, and merging of data pertaining to index chlamydia or gonorrhea cases, Indianapolis metropolitan region, 2016–2020.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

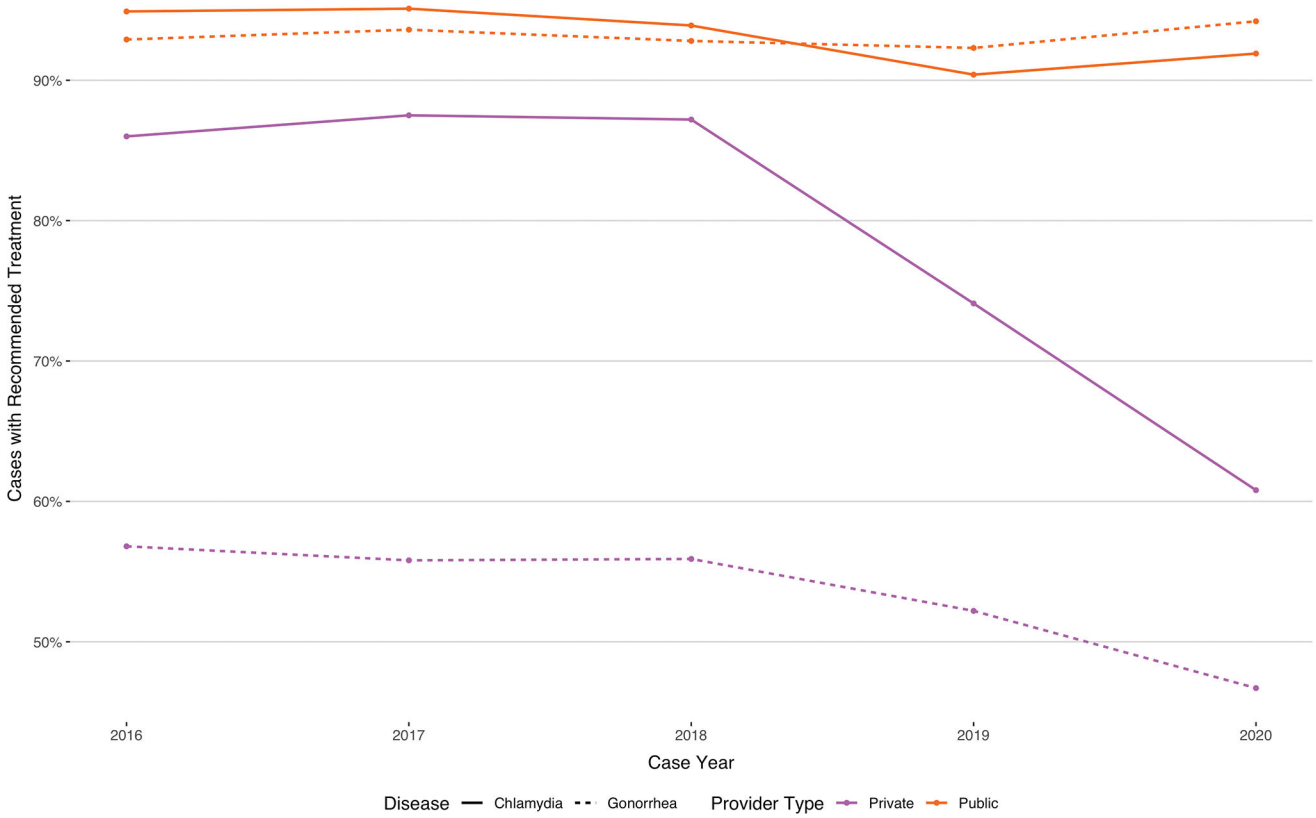

Figure 2.

Treatment rates for chlamydia and gonorrhea over time, stratified by provider type, for the Indianapolis metropolitan region, 2016–2022.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 1.

Cases and treatment rates for chlamydia and gonorrhea from 2016–2020 in the Indianapolis metropolitan region.

	Chlamydia		Gonorrhea		
	Cases (N)	**Recommended Treatment N (%)**	**Cases (N)**	**Any Treatment N (%)**	**Recommended Treatment N (%)**
Total Cohort	52,946	43,539 (82.2%)	25,699	18,973 (73.8%)	16,196 (63.0%)
Provider Type					
Public	9,802	9,182 (93.7%)	6,278	5,934 (94.5%)	5,847 (93.1%)
Private	43,144	34,357 (79.6%)	19,421	13,039 (67.1%)	10,349 (53.3%)
Age group, years					
15–24	32,311	26,617 (82.4%)	10,548	8,592 (81.5%)	7,409 (70.2%)
25–34	15,272	12,587 (82.4%)	8,459	6,602 (78.0%)	5,754 (68.0%)
35–44	4,022	3,272 (81.4%)	3,500	2,432 (69.5%)	2,034 (58.1%)
45–60	1,341	1,063 (79.3%)	3,192	1,347 (42.2%)	999 (31.3%)
Sex					
Female	33,812	27,570 (81.5%)	12,337	8,787 (71.2%)	7,133 (57.8%)
Male	19,003	15,890 (83.6%)	13,292	10,135 (76.2%)	9,016 (67.8%)
Unknown	131	79 (60.3%)	70	51 (72.9%)	47 (67.1%)
Race					
American Indian or Alaska Native	84	73 (86.9%)	35	28 (80.0%)	26 (74.3%)
Asian	501	407 (81.2%)	150	85 (56.7%)	69 (46.0%)
Black or African American	23,341	19,871 (85.1%)	12,793	10,612 (83.0%)	9,444 (73.8%)
Native Hawaiian or Other Pacific Islander	169	134 (79.3%)	67	43 (64.2%)	36 (53.7%)
Two or More Races	1,618	1,396 (86.3%)	843	745 (88.4%)	645 (76.5%)
White	22,187	17,808 (80.3%)	10,619	6,483 (61.1%)	5,118 (48.2%)
Other/Unknown	5,046	3,850 (76.3%)	1,192	977 (82.0%)	858 (72.0%)
Ethnicity					
Hispanic or Latino	4,373	3,662 (83.7%)	1,230	935 (76.0%)	830 (67.5%)
Not Hispanic or Latino	44,645	37,334 (83.6%)	23,249	17,201 (74.0%)	14,694 (63.2%)
Unknown	3,928	2,543 (64.7%)	1,220	837 (68.6%)	672 (55.1%)
Index year					
2016	12,349	10,873 (88.0%)	5,528	4,271 (77.3%)	3,768 (68.2%)
2017	11,198	9,969 (89.0%)	5,596	4,187 (74.8%)	3,707 (66.2%)
2018	10,264	9,080 (88.5%)	4,685	3,528 (75.3%)	3,055 (65.2%)
2019	10,381	7,968 (76.8)	4,748	3,463 (72.9%)	2,878 (60.6%)
2020	8,754	5,649 (64.5%)	5,142	3,524 (68.5%)	2,788 (54.2%)

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 2.

Assessment of provider and patient characteristics associated with receipt of recommended treatment for chlamydia per CDC STI guidelines, Indianapolis metropolitan region, 2016–2020.

	Cases N	Untreated (Reference group) N	Recommended Treatment N (%)	OR (95% CI)	p-value
Total	52,946	9,407 (17.8%)	43,539 (82.2%)		
Provider type					
Public	9,802	620 (6.3%)	9,182 (93.7%)	Ref	
Private	43,144	8,787 (20.4%)	34,357 (79.6%)	0.26 [0.24, 0.29]	< 0.01
Age group, years					
15–24	32,311	5,694 (17.6%)	26,617 (82.4%)	Ref	
25–34	15,272	2,685 (17.6%)	12,587 (82.4%)	1.00 [0.95, 1.06]	0.91
35–44	4,022	750 (18.6%)	3,272 (81.4%)	0.93 [0.86, 1.02]	0.11
45–60	1,341	278 (20.7%)	1,063 (79.3%)	0.82 [0.72, 0.94]	< 0.01
Sex					
Female	33,812	6,242 (18.5%)	27,570 (81.5%)	Ref	
Male	19,003	3,113 (16.4%)	15,890 (83.6%)	1.16 [1.10, 1.21	< 0.01
Unknown	131	52 (39.7%)	79 (60.3%)	0.34 [0.24, 0.49]	< 0.01
HIV					
No	51,984	9,283 (17.9%)	42,701 (82.1%)	Ref	
Yes	962	124 (12.9%)	838 (87.1%)	1.47 [1.22, 1.78]	< 0.01
Race					
White	22,187	4,379 (19.7%)	17,808 (80.3%)	Ref	
American Indian or Alaska Native	84	11 (13.1%)	73 (86.9%)	1.63 [0.90, 3.26]	0.13
Asian	501	94 (18.8%)	407 (81.2%)	1.06 [0.85, 1.34]	0.59
Black or African American	23,341	3,470 (14.9%)	19,871 (85.1%)	1.41 [1.34, 1.48]	< 0.01
Native Hawaiian or Other Pacific Islander	169	35 (20.7%)	134 (79.3%)	0.94 [0.66, 1.39]	0.75
Two or More Races	1,618	222 (13.7%)	1,396 (86.3%)	1.55 [1.34, 1.79]	< 0.01
Other/Unknown	5,046	1,196 (23.7%)	3,850 (76.3%)	0.79 [0.74, 0.85]	< 0.01
Ethnicity					
Not Hispanic or Latino	44,645	7,311 (16.4%)	37,334 (83.6%)		
Hispanic or Latino	4,373	711 (16.3%)	3,662 (83.7%)	1.01 [0.93, 1.10]	0.84
Unknown	3,928	1,385 (35.3%)	2,543 (64.7%)	0.36 [0.34, 0.39]	< 0.01

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 3.

Assessment of provider and patient characteristics associated with receipt of recommended treatment for gonorrhea per CDC STI guidelines, Indianapolis metropolitan region, 2016–2020.

	Cases N	Untreated (Reference group) N	Recommended Treatment N (%)	OR (95% CI)	p-value
Total	22,922	6,726 (29.3%)	16,196 (70.7%)		
Provider type					
Public	6,191	344 (5.6%)	5,847 (94.4%)	Ref	
Private	16,731	6,382 (38.1%)	10,349 (61.9%)	0.10 [0.09, 0.11]	< 0.01
Age group, years					
15–24	9,365	1,956 (20.9%)	7,409 (79.1%)	Ref	
25–34	7,611	1,857 (24.4%)	5,754 (75.6%)	0.82 [0.76, 0.88]	< 0.01
35–44	3,102	1.068 (34.4%)	2,034 (65.6%)	0.50 [0.46, 0.55]	< 0.01
45–60	2,844	1,845 (64.9%)	999 (35.1%)	0.14 [0.13, 0.17]	< 0.01
Sex					
Female	10,683	3,550 (33.2%)	7,133 (66.8%)	Ref	
Male	12,173	3,157 (26.0%)	9,016 (74.0%)	1.42 [1.34, 1.50]	< 0.01
Unknown	66	19 (28.8%)	47 (71.2%)	1.23 [0.73, 2.15]	0.45
HIV					
No	21,899	6,536 (29.8%)	15,363 (70.2%)	Ref	
Yes	1,023	190 (18.6%)	833 (81.4%)	1.87 [1.59, 2.20]	< 0.01
Race					
White	9,254	4,136 (44.7%)	5,118 (55.3%)	Ref	
American Indian or Alaska Native	33	7 (21.2%)	26 (78.8%)	3.00 [1.37, 7.51]	< 0.01
Asian	134	65 (48.5%)	69 (51.5%)	0.86 [0.61, 1.21]	0.38
Black or African American	11,625	2,181 (18.8%)	9,444 (81.2%)	3.50 [3.29, 3.72]	< 0.01
Native Hawaiian or Other Pacific Islander	60	24 (40.0%)	36 (60.0%)	1.21 [0.73, 2.06]	0.47
Two or More Races	743	98 (13.2%)	645 (86.8%)	5.32 [4.31, 6.64]	< 0.01
Other/Unknown	1073	215 (20.0%)	858 (80.0%)	3.22 [2.77, 3.77]	< 0.01
Ethnicity					
Not Hispanic or Latino	20,742	6,048 (29.2%)	14,694 (70.8%)	Ref	
Hispanic or Latino	1,125	295 (26.2%)	830 (73.8%)	1.16 [1.01, 1.33]	0.03
Unknown	1,055	383 (36.3%)	672 (63.7%)	0.72 [0.64, 0.82]	< 0.01