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Outcomes of Traditional and Enhanced Gonorrhea Partner Services in the Strengthening the US Response to Resistant Gonorrhea Project, 2017–2019

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Abstract

INTRODUCTION: The CDC implemented Strengthening the U.S. Response to Resistant Gonorrhea (SURRG) to build local detection and response capacity and evaluate responses to antibiotic-resistant gonorrhea outbreaks, including partner services for gonorrhea. We evaluated outcomes of traditional partner services conducted under SURRG, which involved (1) counseling index patients and eliciting sexual partners, (2) interviewing, testing and treating partners, and (3) providing partner services to partners newly diagnosed with gonorrhea. We also evaluated outcomes of enhanced partner services, which additionally involved interviewing and testing partners of persons who tested negative, and social contacts of index patients and partners.

METHODS: We analyzed partner services investigation data from eight jurisdictions participating in SURRG from 2017 through 2019. We summed total index patients, partners from traditional partner services, and partners and contacts from enhanced partner services, and calculated partner

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services outcomes among partners and contacts. We also visualized sexual networks from partner services data.

RESULTS: Of 1,242 index patients identified, 506 named at least one sexual partner. Traditional partner services yielded 1,088 sexual partners and 105 were newly diagnosed with gonorrhea. Enhanced partner services yielded an additional 59 sexual partners and 52 social contacts. Of those partners and contacts, 3 were newly diagnosed with gonorrhea. Network visualization revealed sparse networks with few complex partnership clusters.

CONCLUSIONS: Traditional partner services for gonorrhea may be useful for eliciting, notifying, and diagnosing partners of index patients in an outbreak setting. Enhanced partner services are unlikely to be effective for eliciting, notifying, and diagnosing a substantial number of additional people.

Short Summary:

Traditional partner services for gonorrhea yielded over 1,000 sexual partners; 105 were newly diagnosed with gonorrhea. Enhanced partner services yielded an additional 59 sexual partners and 52 social contacts.

Keywords

Neisseria gonorrhoeae ; antibiotic resistance; gonorrhea; partner services

INTRODUCTION

Antimicrobial resistance in *Neisseria gonorrhoeae* (the causative bacteria in gonorrhea) remains an urgent public health threat. *N. gonorrhoeae* has progressively acquired widespread resistance to all but one class of antibiotics and only one first-line treatment regimen remains recommended in the United States [1]. Consequently, preparedness for, prevention of, and response to resistant gonorrhea outbreaks is paramount. An essential component of prevention and control of sexually transmitted diseases (STDs) is partner services, a suite of services offered to individuals diagnosed with an STD and their sexual partners. Partner services typically involves 1) counseling individuals diagnosed with an STD and eliciting their sexual partners, 2) interviewing, testing, and treating partners, and 3) providing partner services to those who are newly diagnosed [2]. Currently, due to resource constraints, partner services are predominantly offered to persons newly diagnosed with early syphilis and HIV, but in the event of an outbreak of gonorrhea, expanding partner services to include persons with gonorrhea may be considered. Few recent data about partner services outcomes for gonorrhea are available.

In 2016, the Centers for Disease Control and Prevention (CDC) implemented Strengthening the U.S. Response to Resistant Gonorrhea (SURRG) in eight jurisdictions in the United States to pilot rapid detection and response activities for resistant gonorrhea. One response activity under SURRG was providing partner services for persons with gonorrhea demonstrating reduced antimicrobial susceptibility and their sexual partners. Under SURRG, enhanced partner services were conducted, which, in addition to traditional partner services activities described above, involved interviewing and testing sexual partners of partners

who tested negative for gonorrhea, and social contacts of index patients and partners. It was hypothesized that enhanced partner services could reach people in a sexual-social network who are at risk for or are infected with gonorrhea but are otherwise precluded from investigation and follow-up under traditional partner services. These additional partners could be important for interrupting ongoing gonorrhea transmission and could help better characterize and describe sexual networks through which gonorrhea is transmitted [3,4].

In this paper we sought to understand whether enhanced partner services for gonorrhea could be a feasible and effective control strategy for resistant gonorrhea outbreaks in the US. Specifically, our primary aim was to evaluate outcomes of traditional and enhanced partner services for gonorrhea by comparing outcomes observed under enhanced partner services to outcomes that would be observed under traditional partner services only. To understand the contribution of enhanced partner services, we quantified partner services outcomes in two distinct categories: 1) outcomes that would be observed under traditional partner services only and 2) additional outcomes that were observed under enhanced partner services. Our secondary aim was to better understand whether enhanced partner services can help us elucidate sexual/social networks.

METHODS

This analysis used data from 2017 through 2019 from eight SURRG jurisdictions conducting enhanced partner services for gonorrhea (California (San Francisco County); Colorado (Denver County/Denver); Indiana (Marion County/Indianapolis); Hawaii (Honolulu County/Honolulu); New York City; North Carolina (Guilford County/Greensboro); Washington (King County/Seattle); and Wisconsin (Milwaukee City)).[5] Under SURRG, persons attending STD and community clinics had specimens collected for *N. gonorrhoeae* culture at one or more anatomic sites according to local screening protocols. *N. gonorrhoeae* isolates underwent antibiotic susceptibility testing. As part of what we considered traditional partner services for this analysis, index patients (persons with gonococcal isolates that demonstrated reduced antimicrobial susceptibility, defined as elevated azithromycin (≥ 2ug/ml), ceftriaxone (≥ 0.125 ug/ml), or cefixime (≥ 0.25 ug/ml) minimum inhibitory concentrations (MICs)), were counseled and interviewed by disease intervention specialists (DIS) and asked to provide locating information for all sexual partners within the last two to three months (Figure 1, box A). Sexual partners who were able to be contacted were notified of possible gonorrhea exposure, interviewed, and referred for testing and treatment. Partner services were provided to any partners who tested positive for gonorrhea (Figure 1, box B).

We considered enhanced partner services, a unique addition for SURRG, to include additional interviews and testing for sexual partners of persons who were identified during an investigation and tested negative for gonorrhea (referred to hereafter as a “negative partner”), as well as interviews and testing of social contacts of index patients or sexual partners (Figure 1, box C). Investigations of sexual partners or social contacts continued until a partner or contact was unable to be located or until two consecutive negative partners were identified (i.e., a negative partner named another negative partner).

To promote consistency in the conduct of partner services investigations across jurisdictions, DIS from all jurisdictions were trained in sexual partner and social contact elicitation and interview strategies for SURRG at the beginning of the project. DIS who joined SURRG after the start of the project were trained in-house. They were also encouraged to follow a SURRG interview guide to collect information on epidemiological characteristics and sexual behaviors of index patients, partners, and contacts, such as total number of sexual partners, and number of unnamed sexual partners in the last two to three months. Jurisdictions followed local procedures for the mode of contact and interview (i.e., in-person, phone, etc). Standardized interview, clinical, and laboratory data were submitted by each jurisdiction to CDC for analysis.

We calculated partner services outcomes among index patients and their sexual partners/social contacts identified by partner services investigations from 2017 through 2019. We used a combination of laboratory, clinical, and partner services investigation data to classify persons as either index patients, partners identified via traditional partner services investigations, or partners or social contacts identified via enhanced partner services investigations (i.e., social contacts and/or sexual partners named by investigation-identified persons who tested negative for gonorrhea [Figure 1, box C]). We sought to quantify the absolute impact of gonorrhea partner services, rather than quantify outcomes of individual case investigations. Therefore, each index patient, sexual partner, or social contact was classified once per partner services investigation, and people who were named by more than one index patient or partner within the same investigation were not counted multiple times.

We calculated the number of index patients who were interviewed and who named at least one partner. We also calculated the total number of partners among index patients by adding the number of named partners and total reported unnamed partners by index cases (i.e., partners for whom index patients did not or could not provide locating information). Lastly, we calculated the number of unnamed partners that index patients reported they themselves notified of possible gonorrhea exposure.

Among partners and contacts, we calculated the number of sexual partners who were identified through traditional partner services, and the number of sexual partners and social contacts who were additionally identified through enhanced partner services. We also examined outcomes of successive steps of partner services activities, which we refer to as the partner services cascade, among partners and contacts identified by traditional or enhanced partner services. Steps of the cascade consisted of the numbers of partners or contacts who were named, numbers of partners/contacts not previously tested for or previously diagnosed with gonorrhea in the last 30 days, numbers of partners/contacts that DIS contacted and referred for gonorrhea testing, numbers of partners/contacts tested for gonorrhea using nucleic acid amplification tests, numbers of partners/contacts newly diagnosed with gonorrhea, and numbers of partners/contacts found to have a gonococcal isolate demonstrating reduced antimicrobial susceptibility.

Finally, we calculated the contact index and number needed to interview (NNTI) for traditional partners services only, and traditional and enhanced partners services combined [6]. The contact index, defined as the number of named partners per index case interviewed, was

calculated as the number of named partners via traditional partner services investigations only, or named partners or contacts by traditional and enhanced investigations, divided by the number of interviewed index patients. The NNTI represents the number of index patients needed to interview to identify one new case of gonorrhea, and was calculated as the number of interviewed index patients divided by the number of investigation-identified partners with gonorrhea identified via traditional partner services only, or partners or contacts with gonorrhea identified via traditional plus enhanced partner services.

To understand whether enhanced partner services can help further elucidate sexual/social networks through which *N. gonorrhoeae* is transmitted, we visualized sexual/social networks generated by partner services data using MicrobeTrace (v0.6.1).[7] For each jurisdiction, we mapped all index patients and partners/contacts (i.e., network nodes) identified via partner services investigations and all sexual or social partnerships (i.e., links between nodes). We also mapped each nodes' role in the network (index patient, sexual partner, or social contact) and their gonorrhea status (newly diagnosed positive, previously known positive, negative, unknown, or previously known). We qualitatively assessed network structure complexity under traditional and enhanced partner services by noting the size and complexity of networks and partnership clusters.

CDC's Institutional Review Board reviewed the SURRG protocol and determined the project to be a public health activity and not human subject research.

RESULTS

From 2017 through 2019, 2,441 index patients and named partners or contacts were identified via SURRG partner services investigations in eight jurisdictions (Table 1). Of those, 1,242 were index patients and 1,199 were named partners/contacts (n=1,147 sexual partners identified through traditional or enhanced partner services; n=52 social contacts identified through enhanced partner services). Counts of index patients and partners varied substantially by jurisdiction, with New York City, New York having the highest number of index patients (n=481, 38.7%) and partners (n=321, 26%), and Honolulu County, Hawaii having the lowest number of index patients (n=17, 1.4%) and partners (n=11, 0.9%) (Table 1). Overall, more than 80% of patients and partners were male (n=2,060, 84.4%), and over half of males were men who have sex with men (n=1,214, 58.8%). Most patients and partners were ages 20 through 34 years (n=1,302, 53.3%), and were White (n=522, 21.4%) or Black (n=474, 19.4%). While demographics were complete for index patients, characteristics such as race/ethnicity and gender of sex partner were missing for a large percentage of partners (82.9% and 50.3%, respectively), predominantly due to partners being unlocatable or unwilling to be interviewed.

Partner Services Cascade Outcomes

Of the 1,242 index patients identified, 81.7% (n=1,015) were interviewed by DIS and half of those interviewed named one or more recent sexual partners (n=506, 49.9%) (Figure 2, Table S1). Index patients reported a total of 4,723 partners or social contacts. Index patients did not provide names or locating information for 3,699 (76.5%) of these partners or

contacts. Index patients reported notifying or having plans to notify 751 unnamed partners of possible gonorrhea exposure (range by jurisdiction: 2 – 359).

Across eight jurisdictions, 1,088 sexual partners were named during traditional partner services investigations (i.e., sexual partners of index cases or sexual partners of investigation-identified persons with gonorrhea) (Figure 2 [box B], Table S1). Of those, 960 (88.2%) had not been recently tested for gonorrhea (i.e., not previously tested or diagnosed) and 638 (66.5%) were notified by DIS of possible gonorrhea exposure. One hundred fifty-five (24.3%) of notified partners were verified to have been tested for gonorrhea via NAATs and 105 partners (67.7%) were diagnosed with gonorrhea. Forty-one (39.0%) partners diagnosed with gonorrhea had a specimen collected for culture, and twenty-five (60.9%) of those with a specimen collected for culture had at least one gonococcal isolate demonstrating reduced antimicrobial susceptibility. Counts of partners named, notified, tested and diagnosed via traditional and enhanced partner services varied substantially across jurisdictions (Table S1).

A total of 59 sexual partners were named during enhanced partner services investigations (Figure 2 [box C], Table S1), and 55 (93.2%) had not been recently tested for gonorrhea. Thirty-nine (70.9%) partners were notified of possible exposure, five were verified to have been tested (12.8%) and two were diagnosed with gonorrhea (40.0%). Only one sexual partner had a specimen collected for culture. In addition, 52 social contacts were named during enhanced partner services investigations and 44 (84.6%) had not been recently tested for gonorrhea. Thirty-nine (88.6%) social contacts were notified of exposure by DIS, 6 (15.4%) were verified to have been tested and 1 (20.0%) was diagnosed with gonorrhea. As with traditional partner services, counts of partners or contacts named, notified, and tested varied across jurisdictions, with some jurisdictions identifying no partners or contacts via enhanced partner services (Table S1).

The contact index for traditional partner services was low, with 1.1 partners named for every index patient interviewed. The addition of investigations conducted as part of enhanced partner services very modestly improved the contact index to 1.2. Accordingly, the NNTI was high. Under traditional partner services, 9.7 index patients needed to be interviewed to identify a new case of gonorrhea. The NNTI dropped to 9.4 with additional investigations conducted as part of enhanced partner services.

Sexual/Social Networks

Visualization of sexual/social networks derived from partner services data revealed heterogeneity in the overall size of networks across jurisdictions, but similarities with respect to naming patterns of index patients and partnership cluster complexity (Figure 3). All jurisdictions had a substantial proportion of index patients who named no recent partners (range by jurisdiction: 29.2% - 85.0%), which are represented by single nodes in the network diagrams.

Although we anticipated observing complex clusters with the addition of enhanced investigations, we observed few complex partnership clusters. Most partnerships were one-link dyads (partnerships where one person named one other person) or two-link triads

(partnerships where one person named two people); we observed some clusters in which one person named multiple partners. We also observed few clusters in which most people in the cluster had gonorrhea. The presence or absence of a gonorrhea diagnosis was unable to be determined for many partners (n=496, 41.4% of all partners; range by jurisdiction 20.9% - 68.6%), owing to these individuals being either unlocatable or unwilling to be interviewed or tested for gonorrhea.

Lastly, enhanced partner services did not substantially improve network characterization. Few new partners and partnerships were identified with enhanced partner services. While there was some heterogeneity by jurisdiction, with Marion County, Indiana, Seattle-King County, Washington, and Denver County, Colorado having the most partners and partnerships identified by enhanced partner services investigations, in most jurisdictions, network size and complexity did not grow substantially due to enhanced partner services investigations.

DISCUSSION:

From our examination of gonorrhea partner services outcomes across 8 SURRG jurisdictions from 2017 through 2019, we found that although 1,242 index patients were identified, fewer than half of them named recent sexual partners. Traditional partner services yielded over 1,000 named partners; over half were successfully notified of their exposure, but only one in four of newly diagnosed individuals had a gonococcal infection demonstrating reduced antimicrobial susceptibility. The yield of enhanced partner services was less than that of traditional partner services, with a total of 111 sexual partners or social contacts identified via the enhanced investigations. Of those, only three partners were newly diagnosed with gonorrhea, and none of them were found to have infection demonstrating reduced antimicrobial susceptibility. The contact index was low for both traditional and enhanced partner services, while the number needed to interview to identify a new diagnosis (about ten) was high. Our findings suggest that, in an outbreak setting, traditional partner services for gonorrhea may be used to elicit, notify, and diagnose partners of index patients but enhanced partner services is unlikely to be effective for eliciting, notifying, and diagnosing a substantial number of additional people.

Examination of sexual-social networks derived from partner services revealed predominantly uncomplicated network structures comprised of index patients who named no recent sexual partners, one-link dyads, or two-link triads, but this varied by site. Visualizing sexual/social networks can be helpful for understanding clustering of index patients and sexual partners, and can, in theory, reveal high-risk clusters or clusters of people in which *N. gonorrhoeae* is transmitted [3,8,9]. These clusters are important because they may represent network components that can be leveraged to interrupt onward transmission through information dissemination or cluster fragmentation [10,11]. We observed sparse networks with few clusters of gonococcal infection, and high proportions of index patients who named no sexual partners. Although delineation of clusters through partner services data might be informative for initial characterization of the scope of some outbreaks within sexual networks [12], network interventions involving information dissemination or cluster fragmentation would likely not be successful for containing outbreaks of gonorrhea.

Our analysis revealed several key points in partner services investigations for gonorrhea that impede their ability to interrupt chains of transmission. First, we observed low contact indices, and a high number and proportion of index patients in SURRG who did not report or name sexual partners. Second, among partners who were named and contacted, many likely remained unevaluated for gonorrhea because they refused testing, though it is possible that partners sought testing elsewhere. Unreported, unnamed, and unevaluated partners are potentially exposed and at risk for transmitting *N. gonorrhoeae* and would benefit from screening and treatment, but these partners are unreachable by partner services activities. Barriers related to naming and evaluating partners have also been observed in syphilis and HIV partner services [4,13,14], suggesting that barriers observed in SURRG may not be unique to gonorrhea partner services. Reasons for not reporting or naming partners are varied, complex, and context-specific, and have included distrust of public health officials, previous negative experiences with partner services, lack of understanding about the goal of partner services, and use of dating apps or websites that mask partners' identifying information [15–17]. DIS turnover, and staffing and training challenges, which were common at some SURRG sites, may also be important factors. New strategies that take into account local context and encourage reporting or naming of partners, assist with self-notification of partners, or facilitate screening of partners are needed. Further exploration of outcomes by patient characteristics may also be useful for understanding whether partner services may be more effective in certain subgroups.

It is important to recognize that partner services data can be challenging to collect and interpret. Partner services data and network data are comprised of complex interview data and partnership data that are difficult to collect, clean, and analyze within existing surveillance and case management systems, and collection and analysis requires adequate staff, funding, and systems maintenance. Interpretation of these data can also be challenging. Although standardized data were collected from each jurisdiction participating in SURRG, investigation follow-up, interviews, and case disposition assignment was done according to local partner services protocols and standards. Additionally, definitions for partner services metrics may differ across jurisdictions and studies. In this analysis, we defined index patients as the patient who initiated a partner services investigation, but other studies may characterize index patients as any patient diagnosed with gonorrhea during an investigation. Even with measures to standardize partner services across sites, operational differences and analytic decisions likely account for some variability in partner services outcomes across jurisdictions and within the published literature and should be considered when interpreting these partner services outcomes and findings.

Gonorrhea partner services outcomes in SURRG may not be representative of partner services outcomes for all persons diagnosed with gonorrhea. In SURRG, partner services were offered to patients with *N. gonorrhoeae* demonstrating reduced azithromycin, cefixime, or ceftriaxone susceptibility, and their sexual partners. The outcomes of partner services observed in SURRG may be different than outcomes of partner services offered to persons with susceptible gonorrhea, as patients who are made aware of having an infection demonstrating reduced susceptibility may be more willing or likely to consent to an interview or name partners.

Finally, costs of services can influence partner services outcomes. Jurisdictions participating in SURRG were funded to conduct gonorrhea partner services and collect detailed partner services data. Many jurisdictions do not routinely conduct gonorrhea partner services due to cost and resource constraints. Data describing specific costs associated with partner services conducted under SURRG were not available for all jurisdictions, but partner services can be expensive.[18,19] Costs of staff, travel, equipment, supplies, etc. related to partner services are important factors to consider when examining the success of partner services.

Partner services data are important to analyze to help gauge the efficiency and feasibility of employing partner services for outbreak control. We found that it is feasible to implement rigorously performed partner services for gonorrhea. These activities identified sexual partners who may have been exposed to *N. gonorrhoeae* or may have been at risk of transmitting *N. gonorrhoeae*, and a number of new diagnoses among them. Additionally, although not measured here, partner services may also help facilitate referrals to other important social and health services, such as PrEP initiation, HIV screening, and linkage or re-linkage to HIV care.[2,20] However, additional partners identified by enhanced partner services investigations were few in number, suggesting that enhanced partner services, while feasible, may not be an effective control strategy. Traditional partner services have limitations due to high numbers of unnamed, unreported, and unevaluated partners, but in outbreak settings, partner services would likely be accompanied by strong public health messaging and education for providers and the public, which may help to improve outcomes of gonorrhea partner services. In the absence of other highly effect interventions, partner services may be an important component of controlling an outbreak of resistant gonorrhea.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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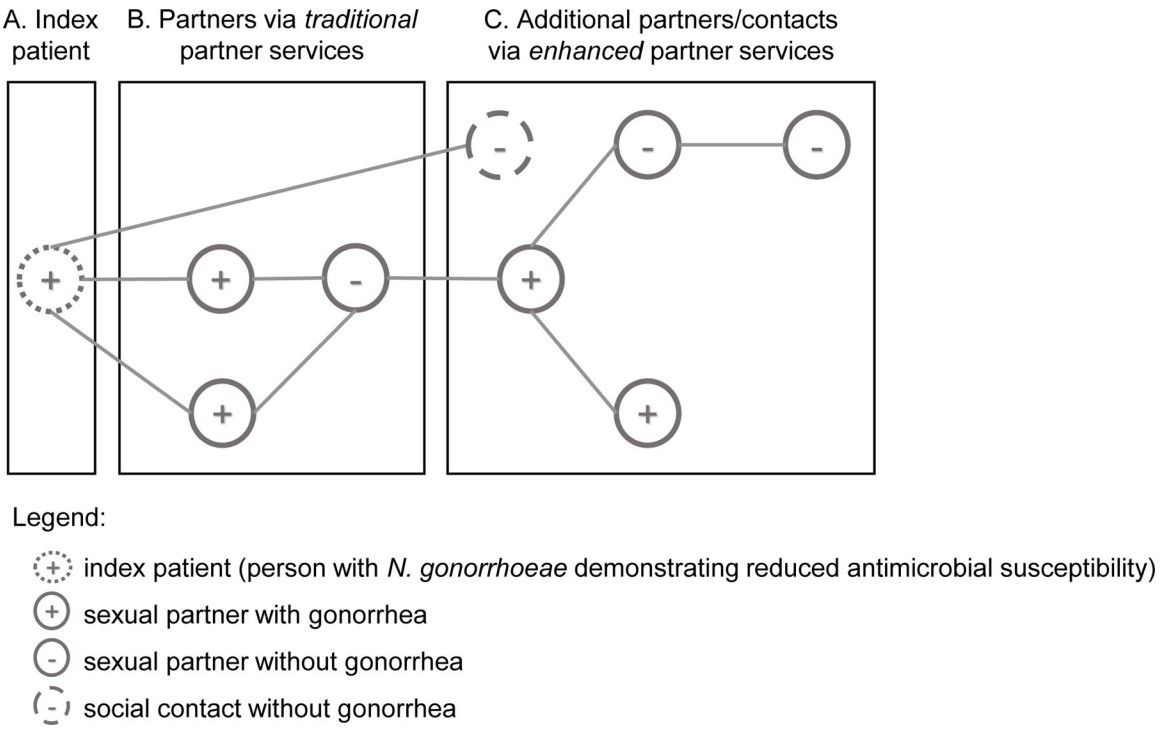
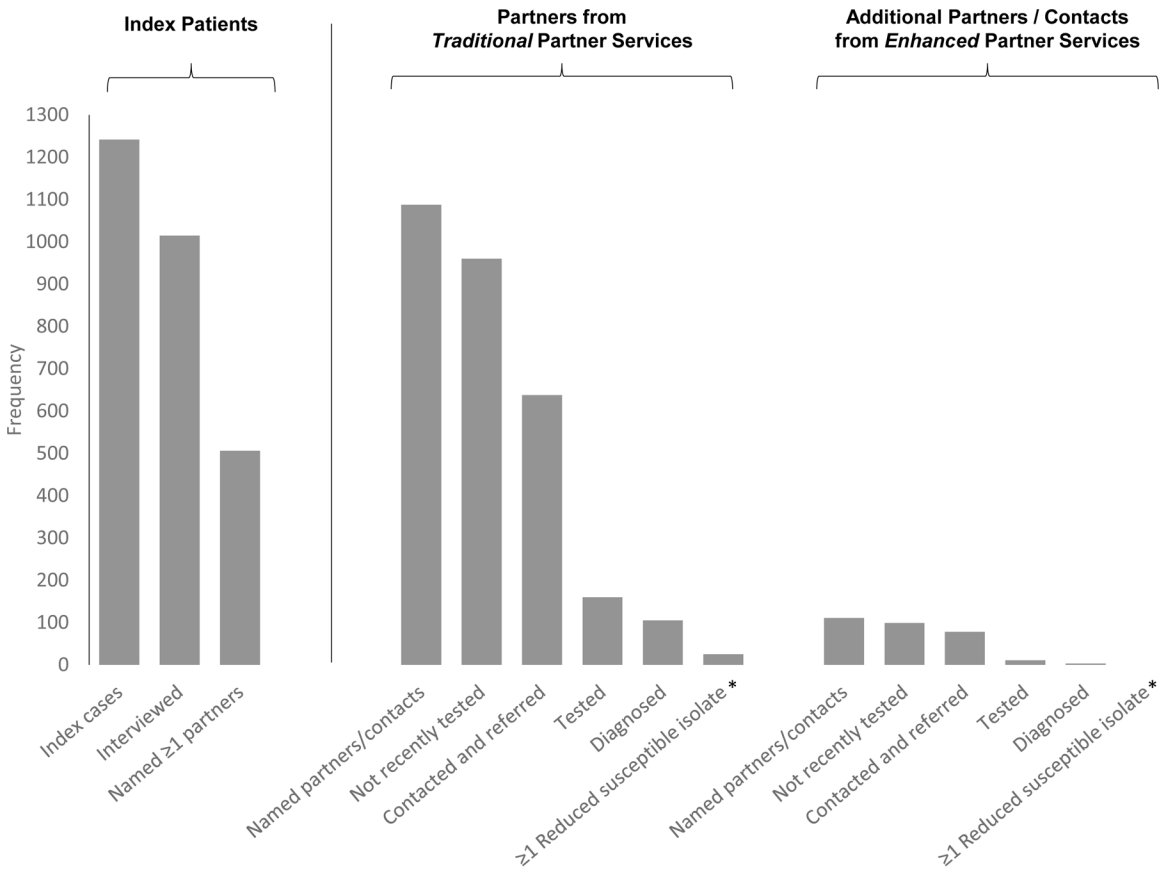


Figure 1:

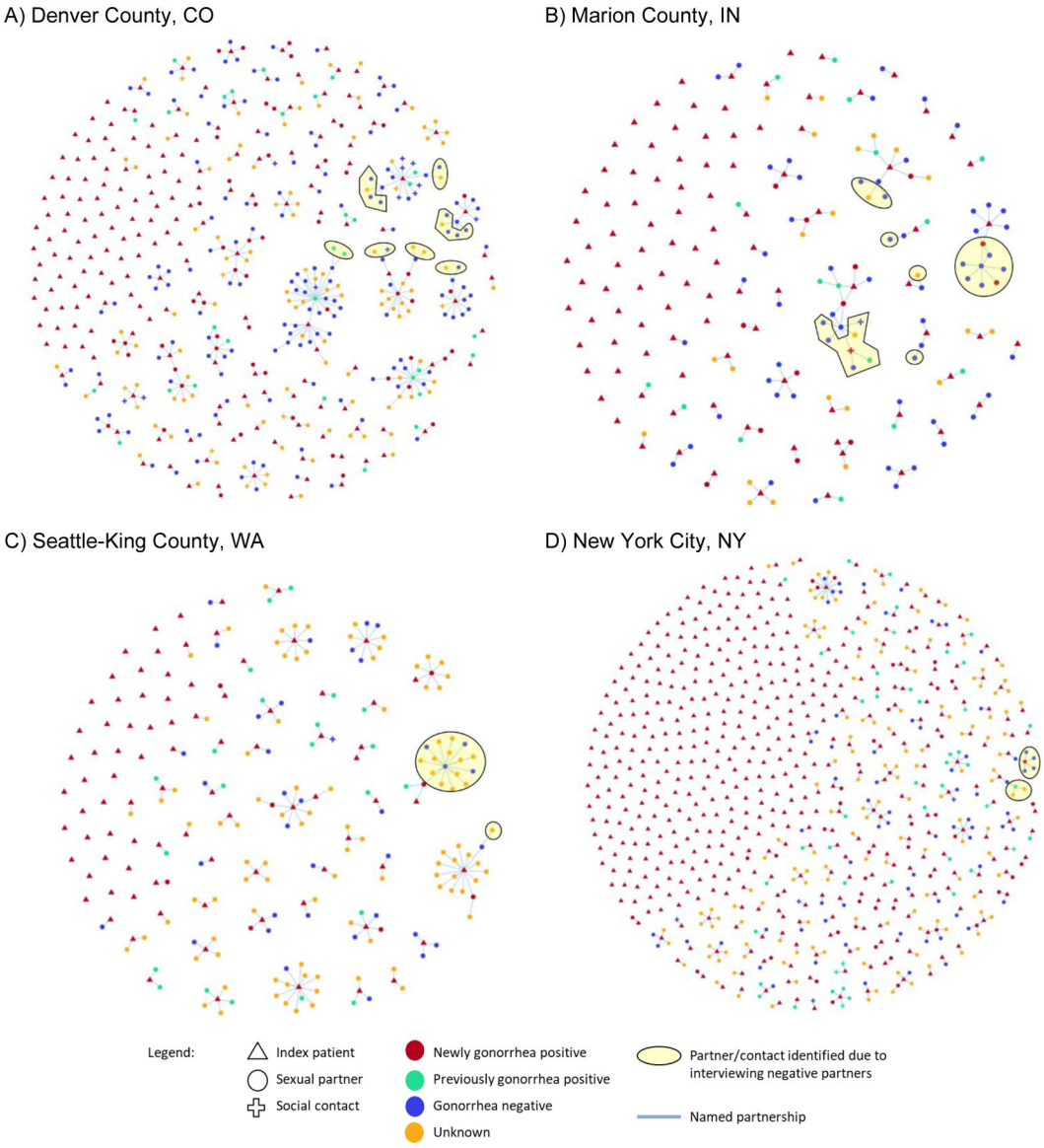
Categorization of patients and partners identified via SURRG services investigations. Traditional partner services involved identifying index patients with gonorrhea with reduced susceptibility to select antibiotics (A), and interviewing and eliciting sexual partners of index patients and persons with gonorrhea (B). Enhanced partner services involved additionally interviewing and eliciting social contacts, or sexual partners of persons without gonorrhea (C).



**N. gonorrhoeae* demonstrating reduced susceptibility, defined as elevated azithromycin (≥ 2ug/ml), ceftriaxone (≥ 0.125 ug/ml), or cefixime (≥ 0.25 ug/ml) minimum inhibitory concentrations

Figure 2:

Partner services cascade for index patients, sexual partners from traditional partner services, and sexual partners and social contacts from enhanced partner services conducted in eight jurisdictions participating in Strengthening the U.S. Response to Resistant Gonorrhea (SURRG), 2017–2019



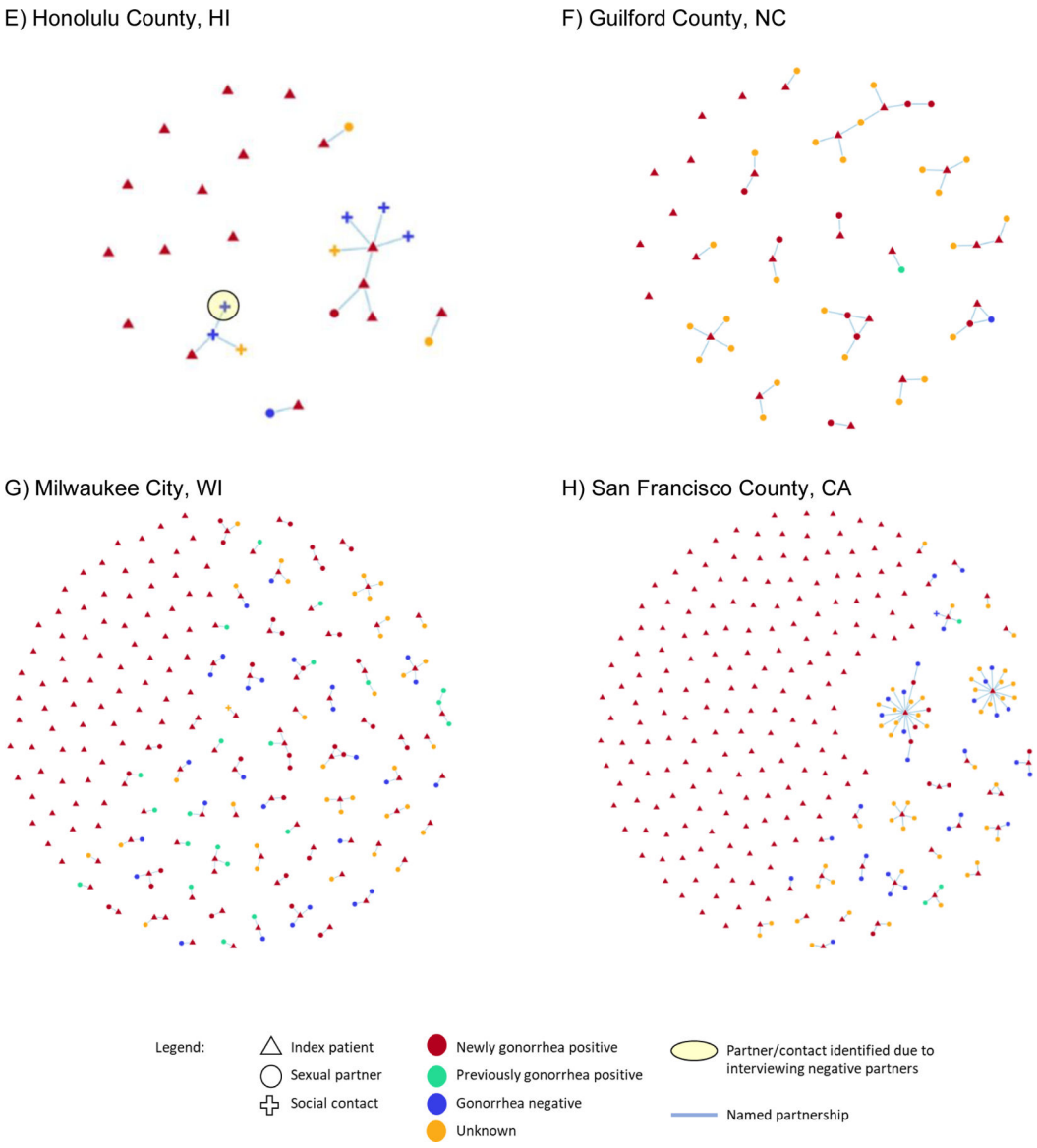


Figure 3:

Sexual-social networks derived from partner services investigations from eight jurisdictions in Strengthening the U.S. Response to Resistant Gonorrhea (SURRG), 2017–2019

Table 1:

Characteristics of index patients and sexual partners and social contacts from partner services investigations conducted in eight jurisdictions participating in Strengthening the U.S. Response to Resistant Gonorrhea (SURRG), 2017–2019

Characteristic	Total (%) (n=2,441)	Index Patients (%) (n=1,242)	Sexual Partners / Social Contacts (%)[1] (n=1,199)
Jurisdiction			
Denver County, CO	543 (22.2)	187 (15.1)	356 (29.7)
Guilford County, NC	59 (2.4)	24 (1.9)	35 (2.9)
Honolulu County, HI	28 (1.1)	17 (1.4)	11 (0.9)
Marion County, IN	216 (8.8)	101 (8.1)	115 (9.6)
Milwaukee City, WI	258 (10.6)	145 (11.7)	113 (9.4)
New York City, NY	793 (32.5)	481 (38.7)	312 (26.0)
Seattle-King County, WA	255 (10.4)	87 (7.0)	168 (14.0)
San Francisco County, CA	289 (11.8)	200 (16.1)	89 (7.4)
Race/Ethnicity			
American Indian/Alaska Native	7 (0.3)	7 (0.6)	0 (0.0)
Asian	87 (3.6)	78 (6.3)	9 (0.8)
Black	474 (19.4)	425 (34.2)	49 (4.1)
White	522 (21.4)	420 (33.8)	102 (8.5)
Hispanic	290 (11.9)	245 (19.7)	45 (3.8)
Unknown	1061 (43.5)	67 (5.4)	994 (82.9)
Gender			
Female	232 (9.5)	59 (4.8)	173 (14.4)
Male	2060 (84.4)	1174 (94.5)	886 (73.9)
Transgender Female	4 (0.2)	1 (0.1)	3 (0.3)
Transgender Male	4 (0.2)	2 (0.2)	2 (0.2)
Unknown	141 (5.8)	6 (0.5)	135 (11.3)
Gender of Sex Partner Among Males			
MSM	1214 (58.8)	823 (70.0)	391 (44.0)
MSW	298 (14.4)	265 (22.5)	33 (3.7)
MSMW	72 (3.5)	55 (4.7)	17 (1.9)
Unknown	480 (23.3)	33 (2.8)	447 (50.3)
Age, years			
14–19	87 (3.6)	49 (3.9)	38 (3.2)
20–24	362 (14.8)	240 (19.3)	122 (10.2)
25–29	550 (22.5)	337 (27.1)	213 (17.8)
30–34	390 (16.0)	259 (20.9)	131 (10.9)
35–39	201 (8.2)	119 (9.6)	82 (6.8)
40–44	148 (6.1)	91 (7.3)	57 (4.8)
45–74	703 (10.1)	147 (11.8)	100 (8.3)
Unknown	456 (18.7)	0 (0.0)	456 (38.0)

[1] Sexual Partners: n=1,147; Social Contacts: n=52