Reactor Grids for Prioritizing Syphilis Investigations: Are Primary Syphilis Cases Being Missed?

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Abstract

BACKGROUND—Health departments prioritize investigations of reported reactive serologic tests based on age, sex, and titer using reactor grids. We wondered how reactor grids are used in different programs, and if administratively closing investigations of low-titer tests could lead to missed primary syphilis cases.

METHODS—We obtained a convenience sample of reactor grids from 13 health departments. Interviews with staff from several jurisdictions described the role of grids in surveillance and intervention. From five jurisdictions, trends in reactive nontreponemal tests and syphilis cases over time (2006–2015) were assessed by sex, age, and titer. In addition, nationally-reported primary syphilis cases (2013–2015) were analyzed to determine what proportion had low titers (1:4) that might be administratively closed by grids without further investigation.

RESULTS—Grids and follow-up approaches varied widely. Health departments in the study received a total of 48,573–496,503 reactive serologies over a ten-year period (3,044–57,242 per year). In 2006–2015, the number of reactive serologies increased 37–169%. Increases were largely driven by tests for males although the ratios of tests per reported case remained stable over time.

Almost one-quarter of reported primary syphilis had low titers that would be excluded by most grids. The number of potentially missed primary syphilis cases varied by sex and age with 41–54 year old males accounting for most.

CONCLUSIONS—Reactor grids that close tests with low titers or from older individuals may miss some primary syphilis cases. Automatic, computerized record searches of all reactive serologic tests could help improve prioritization.

Keywords

syphilis; reactor grids; sexually transmitted diseases; health departments; surveillance

Background

Syphilis is caused by the bacterium *Treponema pallidum* and is highly infectious to sexual partners during the primary and secondary stages. The diagnosis is usually based on treponemal and nontreponemal antibody tests that become positive (or reactive) at some point during primary syphilis.[1] Treponemal tests may sometimes become positive before the nontreponemal test, and usually remain positive for life.[1-3] Nontreponemal antibody titers increase during early syphilis and often remain positive for years following successful treatment. False positive low-titer nontreponemal tests have been associated with a variety of conditions such as HIV infection, autoimmune disease, pregnancy, and injection-drug use. A four-fold increase (e.g., from 1:8 to 1:32) in nontreponemal antibody titer compared to past titers using the same serologic test is evidence of treatment failure or re-infection.

In the early 1960s, many states made positive serologic tests for syphilis reportable as part of their syphilis control efforts.[4] Files of test results were established to allow programs to manually identify new cases and interpret future results. Due to the overwhelming volume of incoming tests, programs developed administrative procedures to prioritize tests for further investigations, with the goal of identifying the reactive serologic results most likely to result in new cases.[5] By the 1970s, 1.4 million positive serologic tests for syphilis were reported each year in the U.S.[6] and half of these were not investigated.[7] Prioritization methods evolved slightly over time into current syphilis reactor grids.

A reactor grid prioritizes syphilis serologic tests based on the patients' age, sex, test type, and test titer.[8] The reactor grid does not apply to cases reported by providers, which are investigated regardless of the test titer. However, as automated electronic laboratory reporting increased,[9,10] case reporting by health providers has become less common.[4,11] Reactive tests are assigned for follow-up or are administratively closed without investigation based primarily on the likelihood of yielding a new infection. In theory, this likelihood is determined by periodically investigating all reported tests to determine how many new infections would have been missed because investigations were closed by the grid.[8,12] However, very few published studies have evaluated reactor grids and those studies used data from select populations (e.g., correctional facilities) during a time when syphilis rates were at historic lows.[13,14] We wondered how syphilis reactor grids were currently being used, and if the focus on high-titer reactors might prevent investigations of primary syphilis cases for which intervention is warranted.

Study aims were to: 1) describe reactor grids and their role in syphilis surveillance and intervention activities, 2) assess trends of reactive nontreponemal tests reported to health departments, 3) examine how many reactive nontreponemal tests are reported for every case of syphilis, and 4) evaluate the potential for missed primary syphilis cases in the U.S.

Materials and Methods

A convenience sample of syphilis reactor grids from diverse health departments were reviewed (Arizona, California, District of Columbia, Florida, Kansas, Louisiana, New York City, North Carolina, Oklahoma, Pennsylvania, Philadelphia, Texas, and Virginia). Staff at various jurisdictions were interviewed for information about the use of reactor grids, data flow between state and local health departments, and programmatic activities and time required to process reported reactive nontreponemal tests.

Surveillance data provided trends in the number of reactive nontreponemal tests (e.g., rapid plasma regain, venereal disease research laboratory) reported to Florida, Louisiana, New York City, Virginia, and Washington D.C. by sex and year from 2006 through 2015. Multiple reports of the same test result for the same person on the same day were de-duplicated. To calculate ratios of the number of tests per case of syphilis (TPC), numbers of all reactive nontreponemal tests with and without titers were compared to the number of syphilis cases of all stages (i.e., primary syphilis, secondary syphilis, early latent syphilis, late latent syphilis, unknown latent syphilis, late syphilis with clinical manifestations, and congenital syphilis) reported in the five jurisdictions.

Florida surveillance data from 2006–2015 were used as an example of the use of a reactor grid in a large public health program. An analysis of the number of reactive tests reported per syphilis case diagnosed (TPC ratio) was conducted using the number of de-duplicated reactive nontreponemal tests with titers as the numerator and number of reported syphilis cases of all stages (with a titer at the time of diagnosis) as the denominator. Reactive nontreponemal tests with titers were de-duplicated using specimen collection date, type of test, and nontreponemal test titer. TPC ratios were calculated for subgroups by age, sex, and test titer to determine the likelihood that an investigation of a test would lead to a reported case. Reactive tests with unknown sex or unknown titers were not included.

Syphilis cases reported to the Centers for Disease Control and Prevention in 2013–2015 were analyzed to see if reactor grids might lead to missing primary cases with low titers. First, we calculated the percentage of reported primary syphilis cases that had non-reactive or low titers (1:4) that might be excluded by reactor grids. Second, because primary syphilis cases have lower test titers than secondary cases, and most grids exclude older persons with low test titers, we computed primary-to-secondary case ratios by age-groups and sex to see if the ratios suggested older age groups were missing primary cases when compared to younger age groups. Potentially missed primary syphilis cases for each age group were estimated as:

$$\frac{P1}{S1} = \frac{P2 + X}{S2} \quad \text{or } X = \frac{P1 * S2}{S1} - P2$$

Where:

> P1 = number of primary syphilis cases (30 years old)
>
> S1 = number of secondary syphilis cases (30 years old)
>
> P2 = number of primary syphilis cases (older age group, e.g., 31-40 years)
>
> X = number of potential missed primary cases (older age group, e.g., 31-40 years)
>
> S2 = number of secondary syphilis cases (older age group, e.g., 31-40 years)

Results

Processing of Reported Syphilis Serologic Results

The approach to investigating reported syphilis serologic results was highly variable across jurisdictions. In general, reactive tests are submitted to health departments by phone, mail, fax, and (most often) electronic laboratory reporting. Sometimes the same positive test is reported multiple times. For example, in one jurisdiction, 13.7% of all reactive nontreponemal tests received by the health department in 2006–2015 were duplicates that had the same specimen collection date. Reports that are not electronic must be manually entered into data systems. For large areas, after health departments receive all reactive serologic tests for syphilis, these are routed to appropriate regional or district offices based on patient address or ordering provider location for further processing (Supplemental Figure 1).

Typically, when a local program receives a reactive test to investigate, it is compared to the health department database to see if the person has previous records in the surveillance and case management system ("profile search"). The report is also assessed for adequacy of information provided by the laboratory or provider and differences in information (e.g., name, address, date of birth, test result) for the same person. One large state health department reported that it took 10–12 person-hours per week to reconcile duplicate syphilis serology records. Deduplication efforts can occur at multiple points during an investigation and are difficult to quantify.

Next, a reactor grid is used to close investigations of laboratory-reported reactive serologies unlikely to lead to a new case. Grids varied in structure and design but all prioritized incoming tests based on patient age, sex, and test titer (Figure 1). In general, priority was given to persons from younger age groups (30 years) and with high titers (1:8). Reactive tests that do not meet the criteria for follow-up, based on low probability of syphilis diagnosis or transmission potential (e.g., 65 year-old with a low titer), are usually administratively closed, not investigated, and not reported as cases unless other circumstances apply. Other circumstances that may lead to further investigations include provider case reports, lab reports from high priority populations (e.g., symptomatic, STD clinic patients, pregnant women, HIV-infected), or lab reports linked to an investigation of another case. The reactor grid would be overruled in these situations. Some reactor grids are applied electronically by surveillance data systems, while others are applied by a staff member reviewing records. Combinations of age and titers selected for administrative

closures from sampled reactor grids varied with age cut-offs that ranged from 20 to 71 years, and titer cut-offs that ranged from 1:4 to 1:32. For example, one jurisdiction administratively closed 25% of all incoming reactive tests while another jurisdiction administratively closed <2%.

Reactive tests that are not administratively closed are compared to old syphilis records to help determine if they represent new infections or old, previously reported and treated infections. The amount of time required to check records can vary depending on the availability of historical laboratory data, number of staff, access to medical records, and changes to patient demographic information. Process data are not readily available at the local level, and the method of estimation is not uniform for sites, but in one jurisdiction, it took an estimated 4–8 minutes to review each record, while another jurisdiction took approximately 13–19 minutes. Field staff in some areas have to contact their state health department for assistance with record searching. Many investigations end after the record search determines that the test titer does not represent a new case (e.g., the patient was previously treated and the current titer is not four-fold higher than the last titer).

For reactive tests being investigated, providers are interviewed by surveillance staff or disease intervention specialists (DIS) to elicit information about clinical assessment, prescribed medications, treatment status, history of infection, social and medical risk factors, and pregnancy status. In some cases, laboratories are contacted about test results that were ordered by providers but were not reported to the health department. The time required for a provider interview in one jurisdiction took 45 minutes to 1 hour. However, the amount of time to contact and speak with providers varied by site. Health department staff stage cases after a provider interview or later in the investigation based on additional information.

For investigations of tests prioritized for DIS follow-up and partner services, patients are often interviewed for risk factors and for information about partners who may be infected. Partners are sought out for notification, testing, and treatment. Index case-patients may participate in memory-jogging exercises (e.g., field tours) and re-interviews for additional sexual partners if the investigation is unable to identify the source of the infection. In-person or phone interviews last from 30 minutes to three hours. Frequency of contact attempts and waiting time for call-back varies by patient.

Trends in Tests and Tests-per-Case Ratio

Trends in the number of reactive nontreponemal tests were obtained for five areas. These health departments received a total of 48,573–496,503 reactive serologies (median = 140,865) over a ten-year period. The number of tests varied by jurisdiction and year, ranging from 3,044 to 57,242. From 2006–2015, the number of tests increased in all areas, with increases ranging from 36.6% in Virginia to 169.2% in Louisiana (Figure 2). The increase was greatest for males (69.5–220.3%). The number of tests for females decreased in two jurisdictions (−21.0–121.4%). The ratio of reported reactive nontreponemal tests per new case of syphilis (TPC) ranged from 6.2 to 11.1 at various jurisdictions (Figure 3). Despite large increases in incoming tests for males, the TPC for males remained relatively stable over time. The TPC ratio was smaller for males than females in all jurisdictions.

Tests Linked to Syphilis Cases by Age, Sex, and Titer

There were 341,363 reactive nontreponemal tests with titers (216,813 males; 124,550 females) reported to Florida Department of Health in 2006–2015 (Table 1). Among males, more than half of tests were for males aged >40 years (59.8%), and males with test titers 1:4 (55.1%). For females, 44.1% of reported tests were among females aged >40 years, and 76.1% had titers 1:4. Overall, there were 6.3 tests per reported case of syphilis in males, and 13.2 tests per reported syphilis case in females (Table 2). Among persons with titers 1:8, TPC ratios for males ranged from 8.2 to 34.4; and for females, from 11.2 to 38.8. Reactors were more likely to represent a new case (smaller TPC ratio) as test titer increased and age decreased. Among females, a direct relationship between increasing age and TPC ratio was observed for those with titers 1:32.

In Florida, the number of cases was likely under-ascertained among persons with low titers and older age groups since their investigations would have been administratively closed by the reactor grid, with the exception of provider-reported cases and other priority individuals (e.g., pregnant women). The TPC ratio was high in shaded areas of the table that would have been administratively closed by the reactor grid without investigation (Table 2).

Potential for Missing Primary Syphilis

Our first estimate of potentially missed primary syphilis cases used the number of primary syphilis cases with test titers 1:4 reported in the U.S. In 2013–2015, there were 18,988 primary syphilis cases reported (17,705 males; 1,283 females) and 15,098 had nontreponemal test titers reported (14,137 males; 961 females) (Table 3). Of these, 23.6% of males and 22.9% of females had results that were reactive, weakly reactive, non-reactive tests, or low titers (1:4).

To see if older age groups were more likely than younger age groups to have missed primary syphilis cases, ratios of primary-to-secondary syphilis cases by age were assessed (Table 4). Compared to 30 year old males, the primary-to-secondary syphilis case ratio in 41–54 year old males was 11.4% smaller. This suggests 488 primary syphilis cases may have been missed in men aged 41–54 years. Ratios for males aged 31–40 years, and 55 years or older were 0.1–0.4% smaller than the referent group suggesting 8 primary syphilis cases might have been missed. Among females, the difference in primary-to-secondary syphilis case ratios for older age groups compared to those aged 30 years or younger grew larger with increased age. The numbers of potential primary syphilis cases missed were: 54 (31–40 year olds), 37 (41–54 year olds), and 12 (55 year olds) for a total of 103 potentially missed female primary syphilis cases.

Discussion

The number of reactive nontreponemal tests reported in select jurisdictions have nearly doubled over the past 10 years, increasing the workload for STD programs already struggling with fiscal challenges.[15,16] Prioritization of investigations is necessary given the large number of false positive tests or previously treated old infections.[17,18] Reactor grids help prioritize serologic syphilis tests for investigation based on age, sex, and nontreponemal

test titer. Although 2–25% of incoming tests were closed by current grids in select jurisdictions, administrative closures could increase if the number of reported tests continues to increase. For instance, more than half of all reactive tests reported in the U.S. were administratively closed in the 1970s amidst high syphilis rates.[7] Furthermore, reactor grids may lead to potential missed cases of primary syphilis that are high priority for treatment and prevention.[1] Trends in the number of reported syphilis cases reflect not only the epidemiology of disease, but are also influenced by the prioritization of reactive tests for follow-up.

Recent increases in reactive tests reported to health departments, particularly among males, may be in part due to frequent screenings of high-risk men who have sex with men (MSM).[1,19] However, it is notable that the number of tests and TPC ratio were likely higher decades ago than today due to widespread screening of low-risk individuals (e.g. premarital screening laws).[5,20] In 1975, the national TPC ratio was approximately 17.4 based on 80,356 reported cases[21] and 1.4 million positive tests[6]. In the current study, the overall 10-year TPC ratios ranged from 6.2 to 11.1 for select jurisdictions. Reasons for site differences are not clear but variable processing algorithms and reactor grid criteria, screening policies (e.g., increased reverse sequence screening in which specimens are first tested with an automated treponemal assay followed by testing reactive sera with a nontreponemal test),[22,23] staff size, available resources, population, and other contextual factors unique to each program could affect the number of reactors prioritized for investigations and reported cases. Stable TPC ratios in males (despite increases in tests) could reflect true increases in disease prevalence and/or more follow-up testing for high-risk individuals.[1,19] Compared to men, higher TPC ratios among women suggest lower disease prevalence and/or threshold for screening (low-risk pregnant women).[24,25]

Our findings using Florida data show the likelihood of finding a syphilis case increases with test titer and younger age. However, the number of reported cases is influenced by the reactor grid, which likely results in under-ascertainment of cases with low titers of older age. The number of truly missed cases for Florida could not be determined; however, based on observed TPC ratios, there was a precipitous drop in the number of cases in areas of the grid that would have been administratively closed without investigation (i.e. older age, low titers). This suggests the low case yield for these areas could partly be an artifact of the grid. Grids that administratively close low titers could lead to missed cases. Future studies could compare findings from provider-reported cases or surveillance data using less restrictive grids.

One in four primary syphilis cases reported in the U.S. had low titers, but this is likely an underestimate of the true proportion because investigations of low-titer tests are often administratively closed. The ratios of primary-to-secondary cases reported suggests almost 600 primary syphilis cases were missed in 2013–2015, mostly among men aged 41-54 years. However, some of these missed primary syphilis cases among older males could be due to MSM who are older than heterosexual men with syphilis[26] and less likely to be diagnosed with primary infections.[27] Missed cases would not likely receive partner services which has important public health implications for groups at high risk for syphilis infection and transmission (e.g. MSM).[21] Among women, more than half of potentially missed primary

cases were within reproductive age (31–40 years). Missed syphilis in women of reproductive age is concerning since untreated syphilis during pregnancy can lead to devastating consequences for the mother and infant.[1,28] Primary syphilitic chancres (skin lesions characteristic of primary syphilis) may go undiagnosed in women (or MSM) because the chancre is painless and not easily visible (e.g., in the vagina, rectum).[29] Thus, all reactive tests for women of reproductive age, regardless of titer, should be investigated to prevent congenital syphilis.

Reactor grids varied in design (e.g., sex, age, test type, and titer), thresholds for investigation or administrative closure, and application during the processing of tests. Thus, the percentage of true missed cases depends on syphilis prevalence among persons with reactive tests and grid design.[14] The true extent to which local reactor grids affected the number of reported syphilis cases in the current study is uncertain. Reactor grids are not frequently evaluated due to the amount of work involved to investigate all reported serologic tests,[8] and grids may change simply because of financial constraints. Previous studies that reviewed data sources not using reactor grids in Chicago in 1998 (i.e., STD clinics, county jail) reported 17% of men, 1% of women, 17% of persons with primary syphilis, and 11% of persons diagnosed with early syphilis would have been excluded by the reactor grid.[13]

The findings in this study are subject to several limitations. Most site-specific data were from high-morbidity areas and may not be representative of low-morbidity jurisdictions. Similarly, the summary approach to investigating reported reactive tests and the role of reactor grids may not be representative to other jurisdictions. In addition, there was no way to determine exactly how jurisdictions were reporting test titers for reported cases that had multiple test titers; for this analysis, the assumption reported was that the test was the "initial laboratory specimen used for diagnosis". Furthermore, confounding due to contextual and individual-level factors (e.g. biologic false positive results, sexual orientation) may have affected the trends in reactive tests reported to jurisdictions or number of potential missed primary cases. Lastly, the number of truly missed cases could not be determined due to lack of information. Similarly, it was unclear how many reactors that were not prioritized for investigation were still treated. Future studies may want to consider assessing missed cases using data from populations universally investigated.

Prioritization of reactive tests might be improved with computerized record searches that automatically compare all reported serologies to old records to see if they are likely to be new cases. Although serologic tests with high titers are likely to yield true syphilis cases, reactor grids could be leading to missed low-titer primary syphilis cases. Reactor grids were introduced at a time when record searches were done by hand looking through paper files. Now, records are electronic but most searches still involve an individual looking at previous serologic test results on a computer. Automating record searches of case registries with at least several years' worth of prior serologic reports could help save time by eliminating previously treated old infections and biologic false positives or duplicate records from unnecessary investigation by surveillance staff or DIS. Already, an automated system for assigning reactor dispositions has been developed and implemented in San Francisco; 44% of reactors would have been automatically closed as an old case or biologic false positive test based on an algorithm applied to retrospective data.[17] Universal record searching would

increase sensitivity in detecting new syphilis infections with fewer missed cases because all reactive tests would be record searched. Registries or databases of non-reactive and reactive results could improve detection of persons with evidence of seroconversion (i.e., non-reactive then reactive tests). Specificity would increase because persons with false positive tests would not be investigated, thus supporting the allocation of program resources towards other activities. While an automated system is not perfect, the potential to save program staff from unnecessary investigations while improving sensitivity with fewer missed cases should be explored. Future research could consider the efficiency gained and cost-savings from implementing automatic record searches.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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GRID A

Age	Nontreponemal Test Titer			
	<1:8	1:8	1:16	≥1:32
0-19	I	I	I	I
20-49	I	I	I	I
50-70	I	I	I	I
>70	AC	AC	I	I

GRID B

Age	Nontreponemal Test Titer							
	WR	R	1:1	1:2	1:4	1:8	1:16	≥1:32
0-30	I	I	I	I	I	I	I	I
31-40	AC	I	I	I	I	I	I	I
41-50	AC	I	AC	I	I	I	I	I
51-60	AC	I	AC	AC	I	I	I	I
61-69	AC	AC	AC	AC	AC	I	I	I
≥70	AC	AC	AC	AC	AC	AC	I	I

GRID C

Age	Treponemal Test Only	Nontreponemal Test Titer					
	R	R	≤1:4	1:8	1:16	1:32	≥1:64
0-44	I	I	I	I	I	I	I
45-54	AC	AC	AC	M-I / F-AC	M-I / F-AC	I	I
≥55	AC	AC	AC	AC	M-I / F-AC	M-I / F-AC	I

GRID D

Age	Treponemal Test Only	Nontreponemal Test Titer						
	R	R	1:1	1:2	1:4	1:8	1:16	≥1:32
Pregnant (any age)	I	I	I	I	I	I	I	I
0-29	I	I	I	I	I	I	I	I
30-39	M-AC / F-I	M-AC / F-I	M-AC / F-I	I	I	I	I	I
40-44	M-AC / F-I	M-AC / F-I	M-AC / F-I	M-AC / F-I	I	I	I	I
45-49	AC	AC	AC	AC	I	I	I	I
50-59	AC	AC	AC	AC	AC	I	I	I
≥60	AC	AC	AC	AC	AC	AC	AC	I

Figure 1.
Reactor grid examples. Grids group reports by age and nontreponemal test titer then assign them for investigation (I) or administrative closure (AC). Some have different cut-offs for males (M) and females (F). R=reactive; WR=weakly reactive.
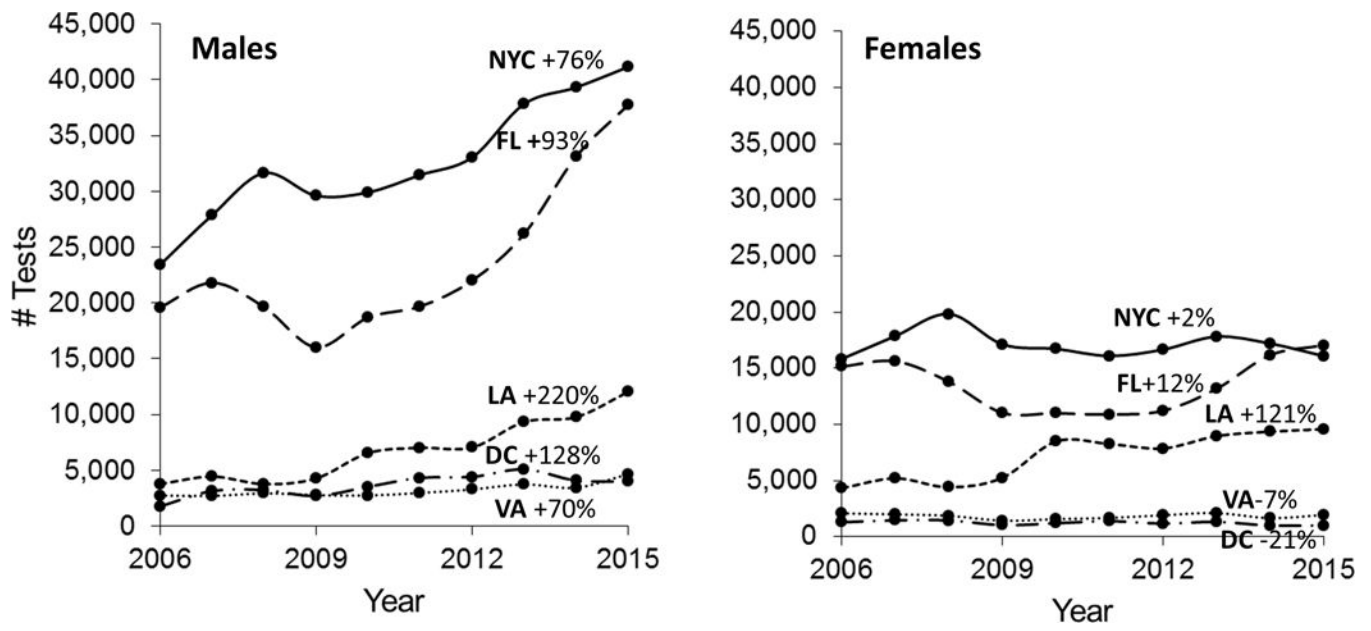
Figure 2.
Number of reactive nontreponemal tests in five U.S. jurisdictions by sex, 2006–2015
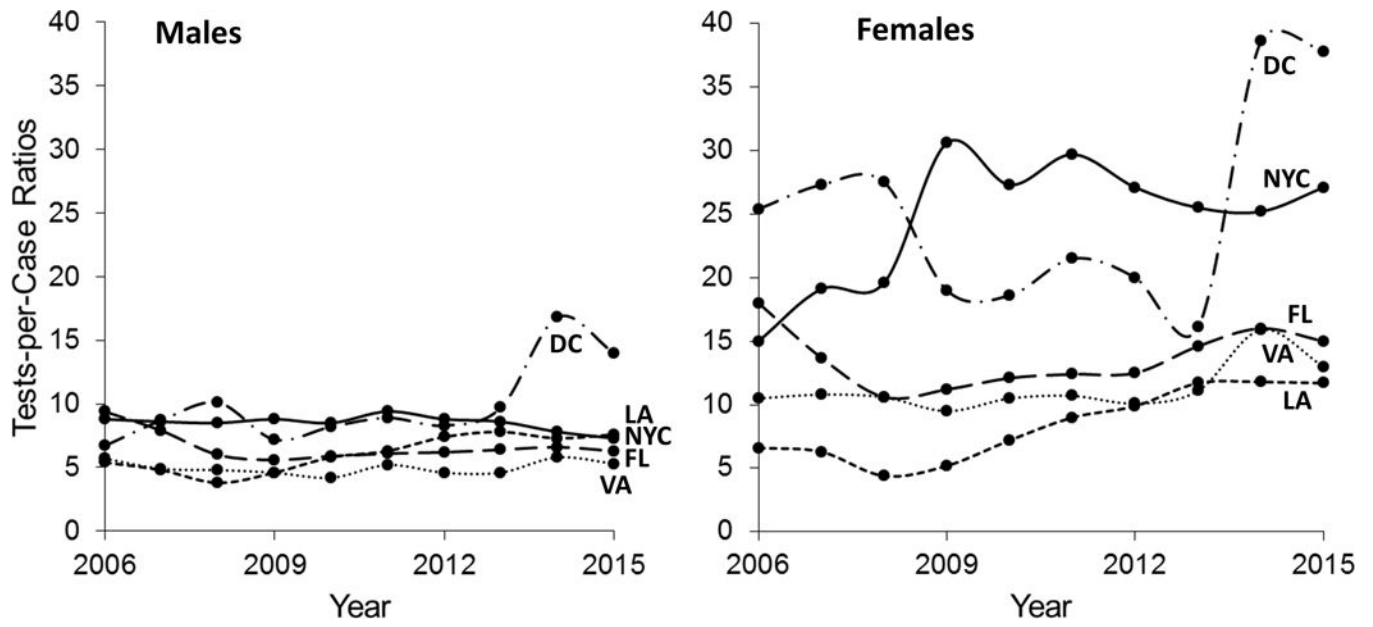
Figure 3.
Syphilis tests-per-case ratios in five U.S. jurisdictions by sex, 2006–2015

Table 1

Reported reactive nontreponemal syphilis tests[1] by age, sex, and titer – Florida, 2006–2015

Age	1:1	1:2	1:4	1:8	1:16	1:32	1:64	Total
Males								
0-20	1,144	901	800	577	555	585	1,641	6,203
21-30	5,418	5,202	4,862	4,635	4,027	3,888	9,677	37,709
31-40	7,559	7,265	6,383	5,369	4,312	3,707	8,557	43,152
41-50	12,541	12,091	9,425	7,491	5,981	4,328	9,642	61,499
51-64	12,191	10,703	7,886	5,693	3,720	2,431	5,192	47,816
65	5,769	5,531	3,854	2,461	1,322	640	857	20,434
Total	44,622	41,693	33,210	26,226	19,917	15,579	35,566	216,813
Females								
0-20	3,087	2,061	1,466	1,000	724	578	1,076	9,992
21-30	10,966	7,613	5,370	3,564	2,087	1,372	2,127	33,099
31-40	9,813	6,883	4,251	2,489	1,372	707	1,059	26,574
41-50	8,032	5,905	3,430	1,971	990	555	920	21,803
51-64	6,275	4,669	2,738	1,651	754	387	482	16,956
65	4,584	4,497	3,194	2,086	1,094	469	202	16,126
Total	42,757	31,628	20,449	12,761	7,021	4,068	5,866	124,550

[1] Number of reactive nontreponemal tests with titers

Table 2

Ratios of reported reactive nontreponemal syphilis tests[1] per case of syphilis – Florida, 2006–2015

Age	1:1	1:2	1:4	1:8	1:16	1:32	1:64	Total
Males								
0-20	21.2	9.5	8.2	4.7	3.0	2.2	1.8	3.6
21-30	14.9	11.1	8.6	5.7	4.0	2.6	1.9	3.8
31-40	14.9	13.2	10.6	7.0	4.9	3.3	2.1	5.1
41-50	58.9	17.0	14.1	9.7	6.3	3.9	2.2	7.0
51-64	99.1	59.5	16.2	9.9	7.3	4.5	2.3	10.2
65	147.9	141.8	85.6	15.3	7.0	5.4	2.9	22.9
Total	34.4	20.4	13.5	8.2	5.3	3.4	2.1	6.3
Females								
0-20	35.5	22.2	14.4	8.3	4.7	2.6	1.9	7.4
21-30	31.4	23.2	15.3	11.1	6.4	3.1	2.0	10.4
31-40	22.2	20.7	16.9	12.3	7.0	3.7	2.1	12.5
41-50	59.5	20.2	17.5	9.8	6.8	4.3	2.6	15.0
51-64	90.9	59.9	13.2	8.3	7.0	4.0	2.7	18.1
65	229.2	173.0	138.9	21.7	7.4	6.5	5.9	38.6
Total	38.8	27.5	18.0	11.2	6.5	3.5	2.2	13.2

[1] Number of reactive nontreponemal tests with titers.

Shaded areas were usually administratively closed without investigation by using the reactor grid; age categories in the table differ from the actual reactor grid such that the grid cut-offs for closing investigations were: >44 years old for females with 1:1 titer, >60 years old for a 1:4 titer, and 70 years old for a 1:8 titer.

Table 3

Nontreponemal test results reported for males and females with primary syphilis — U.S., 2013–2015

	N	%	Cumulative N	Cumulative %
Males				
NR	264	1.9	264	1.9
WR/R	79	0.6	343	2.4
1:1	581	4.1	924	6.5
1:2	1057	7.5	1,981	14.0
1:4	1359	9.6	3,340	23.6
1:8	1938	13.7	5,278	37.3
1:16	1945	13.8	7,223	51.1
1:32	2114	15.0	9,337	66.0
1:64	4800	34.0	14,137	100.0
Females				
NR	7	0.7	7	0.7
WR/R	3	0.3	10	1.0
1:1	49	5.1	59	6.1
1:2	70	7.3	129	13.4
1:4	91	9.5	220	22.9
1:8	116	12.1	336	35.0
1:16	111	11.6	447	46.5
1:32	141	14.7	588	61.2
1:64	373	38.8	961	100.0

NR, non-reactive; WR, weakly reactive; R, reactive.

3,568 male and 322 female primary syphilis cases had unknown titers.

Primary cases with low nontreponemal test titers (shaded) may be underestimated if closed by the reactor grid.

Table 4

Primary to secondary syphilis case ratios by age groups – U.S., 2013–2015

Age Groups	Reported Primary Cases	Reported Secondary Cases	P:S Case Ratio	Case Ratio % Change	# Primary Cases Missing
Males					
30	8,642	17,970	0.481	referent	referent
31-40	4,229	8,802	0.480	−0.1	4
41-54	3,794	8,903	0.426	−11.4	488
55	1,036	2,162	0.479	−0.4	4
Total	17,701	37,837	0.468		496
Females					
30	865	2,717	0.318	referent	referent
31-40	241	925	0.261	−18.2	54
41-54	151	591	0.255	−19.7	37
55	26	120	0.217	−31.9	12
Total	1,283	4,353	0.295		103

P:S, primary to secondary