Subsequent HIV Diagnosis Risk After Syphilis in a Southern Black Population

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Background: Southern non-Hispanic black persons are disproportionately represented in the HIV epidemic. Those previously diagnosed as having syphilis are at significant risk to become HIV infected within 36 months. Effective prevention strategies such as preexposure prophylaxis should be offered to those at highest risk to maximize prevention efforts.

Methods: HIV-negative persons diagnosed as having primary or secondary (P&S) syphilis during 1998–2014 were matched with incident HIV cases diagnosed during 1998–2016 in Shelby County Tennessee. Person-year HIV incidence rate, Kaplan-Meier survival estimates, and Cox proportional regression model analyses were performed to explore predicting risk factors and quantifying risk factors associated with HIV-free survival time frames.

Results: Among 2032 HIV-negative non-Hispanic black Shelby County residents diagnosed as having P&S syphilis, 139 (6.8%) were subsequently diagnosed as having HIV infection. Men who have sex with men (MSM) experienced the highest incidence of HIV diagnosis rate (4.98 per 100 person-years, 95% confidence interval, 4.76–5.2). Being male, MSM, younger than 30 years, or coinfected with gonorrhea increased risk of HIV acquisition 2.32, 11.80, 1.67, and 2.44 times, respectively, compared with being female, heterosexual men, 30+ years old, or not infected with other sexually transmitted infections.

Conclusions: Among our population diagnosed as having P&S syphilis, 1 in 6 MSM and 1 in 16 persons coinfected with gonorrhea were subsequently diagnosed as having HIV during 36 months of follow-up. These findings have implications for HIV screening and recruitment as priority preexposure prophylaxis candidates.

BACKGROUND

HIV disproportionately affects non-Hispanic blacks who accounted for just 12% of the population, yet 45% of new HIV infections were diagnosed in the United States in 2015.[1] Studies of urban men who have sex with men (MSM) on the West Coast and in the northeast of the United States have found that early syphilis is strongly associated with subsequent HIV diagnosis. Whether those studies can be generalized to the Southern United States or whether the risk of subsequent HIV diagnosis is the same for MSM in southern states is unknown, as is the magnitude of the risk. The estimated rate of new HIV diagnoses among black men is more than 8 times the rate for whites.[1] In 2008, the lifetime risk of HIV infection among black men was estimated to be 6.23%, or 1 HIV infection in every 16 black men.[2] By 2016, the Centers for Disease Control and Prevention (CDC) estimated that half of black MSM will be diagnosed as having HIV during their lifetime unless interventions are adopted to change the trajectory of the epidemic,[3] and data from Mississippi suggest that the incidence of HIV among black MSM is rising.[4] In this analysis, we set out to determine whether data collected via routine public health surveillance could be used to identify truly high-risk black MSM clients before they were infected with HIV and drive recruitment into preexposure prophylaxis (PrEP) or other appropriate interventions to prevent progression to HIV disease.

Sexually transmitted infections (STIs) have been identified as potential risk factors for HIV infection.[5] Among men, a recent or concurrent STI including syphilis was associated with acute HIV infection.[6] Prior meta-analysis has suggested a strong relationship between STIs and HIV susceptibility.[7] Especially with high HIV prevalence in certain sexual networks, a person who is exposed to a partner with syphilis is often exposed to HIV during the same sexual encounter.[8] A recent study conducted in San Diego, California, showed that syphilis diagnosis independently predicts subsequent acute and early HIV infection.[9] Similarly, syphilis seropositivity was strongly correlated with positive HIV tests[10] and HIV seropositivity increases the risk of reinfection with syphilis.[11] The randomized study of the cohorts in the Preexposure Prophylaxis Initiative trial conducted in multinational settings[12] also showed significant differences of subsequent HIV infection rates between the comparison group without syphilis infection (2.8, per 100 person-years [100 py]) and the incident syphilis group (8.0/100 py).[13] Pathela et al.,[14] in New York City (NYC), reported the overall risk of subsequent HIV infection among men with primary or secondary (P&S) syphilis at 3.6/100 py, and HIV incidence was 5.6/100 py in their study. A recent study conducted in Washington State by Katz et al.[15] showed significant high HIV incidence rate among HIV-negative MSM with early syphilis at 2.83/100 py.

Randomized controlled PrEP studies[12,16] have demonstrated that using daily oral PrEP significantly reduced the risk of acquiring HIV infection for MSM, heterosexual women who have sex with MSM, and injecting drug users. The CDC also recommended the use of PrEP (tenofovir disoproxil/emtricitabine trade name: Truvada from Gilead Science, Foster City, CA) for sexually active MSM, women who have sex with MSM, and injecting drug users within the HIV prevention framework in May 2014.[17] We hypothesized that the risk of future HIV infection among non-Hispanic black MSM diagnosed as having syphilis in Shelby County would be substantially higher than has been observed in past studies of MSM with STIs, which were undertaken in large, wealthier northern US cities.

Shelby County is an urban southern county that includes the city of Memphis, the largest metropolitan area in Tennessee. The US Census Bureau estimated that Shelby County has a population of 934,603 residents, 53.4% of which were non-Hispanic black residents in 2016.[18] There were 7532 people newly diagnosed as having HIV in Shelby County from 1998 to 2016. Of them, 69% were men and 85% were black. The Shelby County Health Department surveillance data indicate a large burden of syphilis cases among men, and 90% to 96% of our P&S syphilis cases each year are being diagnosed among black residents.[19]

METHODS

The initial study population included 2159 people diagnosed as having either primary or secondary syphilis from

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TABLE 1. Enrollment of P&S Syphilis Cases and Matched HIV Cases in Shelby County, Tennessee (1998–2016)

Race/Ethnicity	P&S Syphilis Cases Enrolled, n (%)*	HIV Cases, n (%)	Subsequent HIV, n (%)
Total	2159 (100)	7532 (100)	149 (6.9)
Black, not Hispanic	2032 (94.1)	6430 (85.4)	139 (6.4)
White, not Hispanic	109 (5.1)	744 (9.9)	10 (0.5)
Hispanic, all races	15 (0.7)	164 (2.2)	0
Other, not Hispanic	3 (0.1)	194 (2.5)	0

P&S Syphilis indicates primary or secondary syphilis.

January 1, 1998, to December 31, 2014, documented in the STI investigation and data management platform used in Tennessee, the Patient Reporting Investigation Surveillance Manager (PRISM). All the STI cases in this analysis were counted based on the specimen collection date. For this cohort study, we excluded syphilis patients younger than 13 years or 65+ years old, assuming for the purposes of this analysis that people between 13 and 64 years old were the most sexually active age range. We also excluded duplicate reports, deceased cases before January 1998 that matched against the Tennessee death records, and HIV-coinfected patients at initial syphilis diagnosis. In addition, given that at least 95% of individuals seroconvert within 2 to 7 weeks after HIV infection,[20] we excluded patients whose HIV diagnosis dates were less than 60 days after their syphilis diagnosis dates to minimize the possibility of including those who acquired syphilis and HIV at the same time but whose initial HIV test result was negative. We identified 2159 unique HIV-negative P&S syphilis cases and matched them against 7532 new HIV cases diagnosed between 1998 and 2016 in the Enhanced HIV/AIDS Reporting System (eHARS). We counted HIV cases in eHARS based on the date of diagnosis. Persons in these 2 registry systems (PRISM and eHARS) were matched based on patient name, soundex, date of birth, social security number, race/ethnicity, and address. Records that matched based on their first name, last name, social security number, and date of birth were regarded as matched cases. Records matched by soundex and date of birth were counted as presumed matches. The presumed matched cases were manually reviewed to determine whether the first and last names had typographical errors, and also were audited for race/ethnicity and address. The race/ethnicity of the study population was determined by the documented race/ethnicity in the surveillance systems (PRISM and eHARS). Black non-Hispanics account for 94% of the study population. All the other race/ethnicity categories combined together comprised only 6% of the study population and 0.5% of the subsequent HIV cases. None of the cases were documented as transgender. We counted men as MSM if they had recorded history of sex with men regardless of also being documented as having heterosexual risk factors. Seeing that black non-Hispanic patients accounted for 94% of the study population and 99.5% of acquired HIV cases, only the black non-Hispanic P&S syphilis cases were included for the remainder of the study (Table 1).

This study was conducted by local health department epidemiologists using variables routinely collected for disease surveillance purposes within our jurisdiction and was not subject to review by the Tennessee Department of Health Institutional Review Board.[21] Data and statistical analysis was conducted using SAS version 9.3. Person-years of follow-up[22] and person-year incidence rates (per 100 py) were estimated by demographic subgroups defined by sex, age at syphilis diagnosis, reported sexual behavior, stages of syphilis, and coinfection with other bacterial STIs. For the model, age at syphilis diagnosis was grouped according to the median age group as "<30 years" and "30+ years." A retrospective cohort study design was used in this study. Kaplan-Meier survival analyses were conducted to identify differences in HIV-free survival time between risk factors. The response variable was 50% HIV-free

TABLE 2. Risk of Subsequent HIV Diagnosis After P&S Syphilis Patients for Non-Hispanic Blacks by Demographic/Behavioral Characteristic in Shelby County, Tennessee (1998–2016)

Demographic/Behavioral Characteristic	P&S Syphilis Cases, n (%)	Subsequent HIV Cases, n (%)	Py of Follow-up, y	Incidence (per 100 py) and 95% CI
Total	2032 (100)	139 (100)	24,073	0.58 (0.570–0.58)
Sex				
Female	889 (43.8)	37 (26.6)	11,408	0.32 (0.318–0.33)
Male	1143 (56.3)	102 (73.4)	12,666	0.81 (0.791–0.81)
Age at syphilis diagnosis, y				
13–24	676 (33.3)	61 (43.9)	7465	0.82 (0.798–0.83)
25–34	594 (29.2)	41 (29.5)	7079	0.58 (0.56–0.59)
35–44	468 (23)	24 (17.3)	5973	0.40 (0.391–0.41)
45–54	226 (11.1)	10 (7.2)	2790	0.36 (0.345–0.37)
55–64	68 (3.3)	3 (2.2)	766	0.39 (0.364–0.4)
Risk				
Women	889 (43.7)	37 (26.6)	11,408	0.32 (0.32–0.33)
Heterosexual men	825 (40.6)	9 (6.5)	10,799	0.08 (0.08–0.08)
MSM	318 (15.6)	93 (66.9)	1867	4.98 (4.76–5.21)
Stages of syphilis				
Primary syphilis	384 (18.9)	16 (11.5)	4906	0.33 (0.31–0.33)
Secondary syphilis	1648 (81.1)	123 (88.5)	19,167	0.64 (0.632–0.65)
Coinfection status				
Coinfected (with STIs)	529 (26)	49 (35.3)	4897	1.00 (0.972–1.0)
Not coinfected (with STIs)	1503 (74)	90 (64.7)	19,177	0.47 (0.462–0.47)

*Other STIs include chlamydia and/or gonorrhea only.

CI indicates confidence interval; MSM, men who have sex with men; P&S Syphilis, primary or secondary syphilis.

TABLE 3. Twelve-, 24-, and 36-Month Risk of Subsequent HIV Diagnoses After P&S Syphilis Cases for Non-Hispanic Blacks by Demographic/Behavioral Characteristic in Shelby County, Tennessee (1998–2016)

		12 mo		24 mo		36 mo	
	50% HIV-Free Survival and 95% CI, mo	HIV cases (n)	No. HIV Cases, 1 in	HIV Cases (n)	No. HIV Cases, 1 in	HIV Cases (n)	No. HIV Cases, 1 in
All	38.7 (30.3–45.3)	20	102	49	41	65	31
Sex							
Female	46.9 (38.1–67.4)	2	445	8	111	9	99
Male	31.5 (24.9–42.5)	18	64	41	28	56	20
Age at syphilis diagnosis, y							
13–24	41.5 (29.2–46.9)	7	97	17	40	27	25
25–34	30.3 (15.1–47.2)	9	66	20	30	23	26
35–44	35.2 (16.3–53.8)	3	156	10	47	12	39
45–54	58.4 (12.9–78.8)	1	226	2	113	3	75
55–64	114.1 (82.3–167.9)	N/A	N/A	N/A	N/A	N/A	N/A
Risk							
Women	46.9 (38.1–67.4)	2	445	8	111	9	99
Heterosexual men	55.9 (8.8–114.1)	1	825	2	413	3	275
MSM	29.6 (24.5–41.5)	17	19	39	8	53	6
Stages of syphilis							
Primary syphilis	45 (16.3–85.6)	2	192	5	77	6	64
Secondary syphilis	38.1 (29.2–43.7)	18	92	44	37	59	28
Coinfection status							
Coinfected (with STIs*)	34.9 (25.2–41.6)	8	66	17	31	25	21
Not coinfected (with STIs)	42.6 (30.3–53.8)	12	125	32	47	40	38

*Other STIs include chlamydia and/or gonorrhea only.

CI indicates confidence interval; MSM, men who have sex with men; N/A, not applicable; P&S Syphilis, primary or secondary syphilis.

survival time, defined as time in months between the date of initial P&S syphilis diagnosis to HIV diagnosis date for 50% of patients in definable risk groups or, in the case of 50% of persons who were not identified with HIV (censored), the time in months of follow-up through the end of 2016. The patients in this cohort who were not diagnosed as having HIV and who died during the follow-up time were also included as censored cases. The 50% HIV-free survival times and probability of risk factors associated with HIV-free survival were also explored among this cohort. We used the Cox proportional hazards regression model to identify predictors of survival and risk factors associated with subsequently testing HIV positive. All the tests were 2-sided, and the criterion for statistical significance was set at $P < 0.05$. Data were represented in tabular form with estimate values.

RESULTS

Between January 1, 1998, and December 31, 2014, 2032 black non-Hispanic P&S syphilis cases that did not have evidence of prior or concurrent HIV infection were included for the study. The mean age was 32.1 years (range, 13.5–64.7 years), and the median age was 30 years. More than half of the cases were male (56.3%) and young adults aged 13–34 years (62.5%). Most acquired P&S syphilis through heterosexual (heterosexual men or women) contact (84.4%). Although 15.6% of P&S syphilis cases were infected through MSM contact, the highest proportion (66.9%) of them were subsequently diagnosed as having HIV. None of the cases in this cohort were identified as transgender. Most cases were initially diagnosed as having secondary syphilis (81.1%). More than two thirds of the study cohort was lacking evidence of coinfection with other bacterial STIs (Table 2).

The 2032 black persons with P&S syphilis contributed 24,073 py of follow-up time from 1998 through 2016. During the follow-up period, 139 (6.9%) P&S syphilis–infected persons were subsequently diagnosed as having HIV. For those, the mean time from syphilis to HIV diagnoses was 48.3 months (range, 2.4–167.9 months). The overall annual HIV incidence rate was 0.58/100 py for specific subpopulations; however, the annual incidence rate was greater. Incidence rates were highest among MSM (4.98/100 py), persons coinfected with other STIs (1.0/100 py), the younger age group (13–24 years; 0.82/100 py), males (0.81/100 py), and persons diagnosed as having secondary syphilis (0.64). Overall, persons coinfected with other bacterial STIs had twice the incidence rate of those without STI coinfection.

Kaplan-Meier survival estimates (Table 3) show that the 50% HIV-free survival time for the study cohort was 38.8 months. One in 20, 1 in 9, and 1 in 6 MSM with syphilis were subsequently infected with HIV within 12, 24, and 36 months, respectively. One in 20 syphilis patients coinfected with other bacterial STIs was subsequently infected with HIV within 36 months; 1 in 16 coinfected with gonorrhea was subsequently infected with HIV within 36 months.

Hazard ratio analysis in Cox proportional regression model (Table 4) shows that persons with P&S syphilis who were male, MSM, diagnosed as having syphilis at age less than 30 years, diagnosed as having secondary syphilis, and/or coinfected with gonorrhea all had significant risks of becoming infected with HIV. Among persons with P&S syphilis, being male (hazard ratio, 2.30; 95% confidence limit, 1.59–3.38) or coinfection with gonorrhea (hazard ratio, 2.44; 95% confidence limit, 1.65–3.59) doubled the risk of HIV infection compared with females or those coinfected with chlamydia or not infected with other

TABLE 4. Hazard Ratio for HIV Diagnosis Among Non-Hispanic Blacks With P&S Syphilis in Shelby County, Tennessee (1998–2016)

Parameters	Hazard Ratio	95% Hazard Ratio Confidence Limits
Sex		
Male	2.32	1.59–3.38
Female	1.00	
Risk		
Heterosexual men	0.25	0.12–0.53
MSM	11.8	7.9–17.6
Women	1.00	
Age at syphilis diagnoses, y		
13–24	2.19	0.69–6.97
25–34	1.61	0.49–5.2
35–44	1.16	0.35–3.84
45–54	0.99	0.27–3.6
55–64	1.00	
Stages of syphilis		
Secondary syphilis	1.87	1.11–3.15
Primary syphilis	1.00	
Coinfection status		
Coinfected (with STIs*)	1.78	1.25–2.52
Not coinfected (with STIs)	1.00	
Coinfection with other STIs		
Chlamydia coinfection	1.02	0.57–1.82
Gonorrhea coinfection	2.44	1.65–3.59
None (syphilis only)	1.00	

*Other STIs include chlamydia and/or gonorrhea only.

CL indicates confidence limit; MSM, men who have sex with men; P&S Syphilis, primary or secondary syphilis.

bacterial STIs. For a detailed description of each risk factor we analyzed and the hazard ratios associated, please refer to Table 4.

DISCUSSION

This cohort study showed that among our population of southern non-Hispanic blacks with P&S syphilis, being MSM had the highest HIV incidence rate, the shortest HIV-free survival time, and the highest hazard ratio to be infected with HIV at any time point. Being male or coinfected with other bacterial STIs significantly increased the risk of subsequent HIV infection. Our analysis suggests that agencies can use their own STI surveillance data to identify high-risk HIV-negative patients and prioritize them for PrEP recruitment, making the best use of data to target an intervention to those at absolute greatest risk of quickly progressing to HIV infection.

The overall annual HIV incidence rate (0.81/100 py) among black men in Shelby County was lower than that found in similar studies in Florida (1.78/100 py)[23] and NYC (4.7/100 py),[14] yet consistent with Vittinghoff et al.,[24] which showed that new HIV infections were highly concentrated among MSM. Although our rate (4.98/100 py) was slightly lower than that found in NYC (5.6/100 py), this measure was twice the overall estimate of HIV incidence rate (2.39/100 py) for MSM in the United States[25] and MSM with early syphilis in Washington State.[14] In addition, our analysis showed that the annual HIV incidence rate ratio between MSM and heterosexual patients in Shelby County (62.3) was more than 13 times that documented in NYC (4.63). Kaplan-Meier survival analysis estimates (Table 3) that 1 in 6 MSM diagnosed as having P&S syphilis subsequently acquired HIV within 36 months. Of the subsequently diagnosed HIV cases, 50% of MSM cases were diagnosed as having HIV almost 2 times faster (mean, 29.6 months) than 50% of heterosexual men diagnosed as having HIV (mean, 55.9 months).

In this cohort, the high incidence rate of subsequent HIV infection among those coinfected with other bacterial STIs clearly suggests ongoing sexual transmission risk for HIV.[24] The annual HIV incidence rate among those coinfected with other bacterial STIs was more than double those not coinfected with other bacterial STIs. Kaplan-Meier survival analysis also estimates (Table 3) that 1 in 20 P&S syphilis patients coinfected with other bacterial STIs acquired HIV within 36 months compared with those 1 in 38 patients with syphilis only. Cox proportional regression model (Table 4) shows that being coinfected with gonorrhea yielded a significantly higher hazard ratio (2.44) than being coinfected with chlamydia (1.02); 1 in 16 coinfected with gonorrhea was subsequently infected with HIV within 36 months.

This cohort analysis has limitations. Persons diagnosed as having P&S syphilis before 1998 and patients who migrated into Shelby County were considered to be free from other bacterial STIs (chlamydia and/or gonorrhea) because of the lack of documentation of prior testing data in our electronic surveillance system. We may have underestimated the true HIV incidence rate when P&S syphilis patients did not have HIV tests conducted during the study period, and patients not reporting HIV diagnoses received outside Tennessee may not be captured in the Tennessee HIV registry. In addition, any missing reports of P&S syphilis in PRISM or unreported HIV cases may have also led to underestimating the true HIV incidence rate in this cohort. We may have overestimated the risk for HIV if the patients were coinfected with HIV at the time of syphilis diagnosis but did not test for HIV within 60 days of syphilis diagnosis. The assessment of the risk of infection with other bacterial STIs may have been underestimated among the cohort because of the underreported STIs or missed diagnoses of asymptomatic chlamydia and gonorrhea.[26] During the follow-up period, we did not estimate the relationship between repeated syphilis infection and incident HIV infection.

This cohort analysis highlights the significance of HIV and other bacterial STI screening among P&S syphilis patients. The CDC recommends that all HIV-negative sexually active MSM and all persons who are seeking evaluation and treatment of STIs should be screened annually for HIV infection.[27] Given the range (2.4–167.9 months) from P&S syphilis to subsequent HIV diagnoses and considerable HIV risks that were measured, HIV-negative syphilis patients should perhaps be screened as often as every 3 to 6 months. Taking a comprehensive sexual history and routinely screening for bacterial STIs is also crucial for MSM. Providers diagnosing syphilis patients, especially MSM, sexually active females, or persons coinfected with other bacterial STIs regardless of sex should recommend using PrEP in combination with using condoms to effectively prevent HIV transmission. These estimates indicate the need for even more effective HIV prevention care efforts such as PrEP and frequent HIV testing among black men with P&S Syphilis and especially MSM coinfected with other bacterial STIs to reduce HIV transmission among this population.

REFERENCES

1. Centers for Disease Control and Prevention. HIV Among African Americans. Available at: https://www.cdc.gov/hiv/group/racialethnic/africanamericans/index.html.
2. Hall HI, An Q, Hutchinson AB, et al. Estimating the lifetime risk of a diagnosis of the HIV infection in 33 states, 2004–2005. J Acquir Immune Defic Syndr 2008; 49:294–297.
3. CROI Press Release: Lifetime Risk of HIV Diagnosis 2016. Available at: https://www.cdc.gov/nchhstp/newsroom/2016/croi-press-release-risk.html.
4. Chan GA, Johnson KL, Mosca NG, et al. Emerging regional and racial disparities in the lifetime risk of human immunodeficiency virus infection among men who have sex with men: A comparative life table

analysis in King County, WA and Mississippi. Sex Transm Dis 2017; 44:227–232.
5. Scott KC, Philip S, Ahrens K, et al. High prevalence of gonococcal and chlamydial infection in men who have sex with men with newly diagnosed HIV infection: An opportunity for same-day presumptive treatment. J Acquir Immune Defic Syndr 2008; 48:109–112.
6. Zetola NM, Bernstein KT, Wong E, et al. Exploring the relationship between sexually transmitted diseases and HIV acquisition by using different study designs. J Acquir Immune Defic Syndr 2009; 50:546–551.
7. Sexton J, Garnett G, Røttingen JA. Metaanalysis and metaregression in interpreting study variability in the impact of sexually transmitted diseases on susceptibility to HIV infection. Sex Transm Dis 2005; 32: 351–357.
8. Buchacz K, Klausner JD, Kerndt PR, et al. HIV incidence among men diagnosed with early syphilis in Atlanta, San Francisco, and Los Angeles, 2004 to 2005. J Acquir Immune Defic Syndr 2008; 47: 234–240.
9. Hoenigl M, Green N, Mehta SR, et al. Risk factors for acute and early HIV infection among men who have sex with men (MSM) in San Diego, 2008 to 2014: A cohort study. Medicine (Baltimore) 2015; 94:e1242.
10. Kane MA, Bloch EM, Bruhn R, et al. Demographic determinants of syphilis seroprevalence among U.S. blood donors, 2011–2012. BMC Infect Dis 2015; 15:63.
11. Ogilvie GS, Taylor DL, Moniruzzaman A, et al. A population-based study of infectious syphilis rediagnosis in British Columbia, 1995–2005. Clin Infect Dis 2009; 48:1554–1558.
12. Grant RM, Lama JR, Anderson PL, et al. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. N Engl J Med 2010; 363:2587–2599.
13. Solomon MM, Mayer KH, Glidden DV, et al. Syphilis predicts HIV incidence among men and transgender women who have sex with men in a preexposure prophylaxis trial. Clin Infect Dis 2014; 59:1020–1026.
14. Pathela P, Braunstein SL, Blank S, et al. The high risk of an HIV diagnosis following a diagnosis of syphilis: A population-level analysis of New York City men. Clin Infect Dis 2015; 61:281–287.
15. Katz DA, Dombrowski JC, Bell TR, et al. HIV incidence among men who have sex with men after diagnosis with sexually transmitted infections. Sex Transm Dis 2016; 43(4):249–254.
16. Baeten JM, Donnell D, Ndase P, et al. Antiretroviral prophylaxis for HIV-1 prevention among heterosexual men and women. N Engl J Med 2012; 367:399–410.
17. US Public Health Service. Preexposure Prophylaxis for the Prevention of HIV Infection in the United States—2014.
18. U.S. Census Bureau/American FactFinder. 'S0601' Selected Characteristics of the Total and Native Populations in the United States, 2016 American Community Survey 1-Year Estimate.
19. Shelby County Health Department, TN. HIV Disease and STD Annual Surveillance Summary 2015. Available at: http://www.shelbytnhealth.com/233/Reports-Data-Tables. Accessed March 9, 2017.
20. Lindbäck S, Thorstensson R, Karlsson AC, et al. Diagnosis of primary HIV-1 infection and duration of follow-up after HIV exposure. AIDS 2000; 14:2333–2339.
21. Centers for Disease Control and Prevention. "Distinguishing Public Health Research and Public Health Nonresearch" Policy. Available at: https://stacks.cdc.gov/view/cdc/24235. Accessed March 9, 2017.
22. Centers for Disease Control and Prevention. Principles of Epidemiology in Public Health Practice, Third Edition. An Introduction to Applied Epidemiology and Biostatistics. Available at: https://www.cdc.gov/ophss/csels/dsepd/ss1978/index.html. Accessed March 9, 2017.
23. Peterman TA, Newman DR, Maddox L, et al. High risk for HIV following syphilis diagnosis among men in Florida, 2000–2011. Public Health Rep 2014; 129:164–169.
24. Vittinghoff E, Douglas J, Judson F, et al. Per-contact risk of human immunodeficiency virus transmission between male sexual partners. Am J Epidemiol 1999; 150:306–311.
25. Stall R, Duran L, Wisniewski SR, et al. Running in place: Implications of HIV incidence estimates among urban men who have sex with men in the United States and other industrialized countries. AIDS Behav 2009; 13:615–629.
26. Paxton LA, Sewankambo N, Gray R, et al. Asymptomatic nonulcerative genital tract infections in a rural Ugandan population. Sex Transm Infect 1998; 74:421–425.
27. Centers for Disease Control and Prevention. Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings. MMWR 2006; 55:1–17.