Incident Syphilis among Women with Multiple Admissions to Jail in New York City

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Although early syphilis morbidity in New York City (NYC) has declined to a record low, syphilis seroreactivity among women jailed in NYC is ~25%. By use of a retrospective cohort–type analysis of longitudinal serologic and treatment data collected at the time of each incarceration, the incidence of syphilis infection among 3579 susceptible women jailed multiple times in NYC between 23 March 1993 and 10 April 1997 was estimated. Syphilis incidence densities were estimated by use of continuous, time-homogeneous Markov models. There was a total of 289 incident infections. The overall incidence density was 6.5 infections per 100 woman-years (95% confidence interval, 5.7–7.2), which exceeds the 1997 early syphilis rate among women in NYC by >1000-fold. The persisting high incidence of syphilis in this population underscores the importance of aggressive syphilis control in correctional settings, even in the face of declining local early syphilis rates.

After a major epidemic in the late 1980s, rates of reported early syphilis in New York City (NYC) have steadily declined since 1990 (figure 1). Despite these record low rates, syphilis seroreactivity among women detained at the NYC women's jail remains high. NYC detainees are routinely screened serologically for syphilis at incarceration. The microhemagglutination–*Treponema pallidum* (MHA-TP)–confirmed seroreactivity rate in the women's jail between 1991 and 1997 was ~25%; the rapid plasma reagin (RPR) seroreactivity over the same period was ~30% (NYC Health and Hospitals Corporation, Division of Correctional Health Services, 1998, unpublished data). This exceeds the 0%–16% reported for women in other correctional facilities [1–3]. The Rapid Syphilis Screening and Treatment program (also called the STAT program), instituted at the NYC women's jail in 1993 [4], may have contributed to NYC's achieving, in 1997, the lowest reported syphilis rates since surveillance was initiated in 1940 [5]. However, monitoring syphilis seroreactivity does not by itself yield an estimate of syphilis incidence in this population. Reactive serologies must be interpreted in the context of history, physical examination, and treatment history to distinguish new cases from previous infections that received adequate treatment. Our objective was to estimate the incidence density of newly acquired syphilis infections among a retrospective cohort of women for whom this was feasible—those with multiple incarcerations in ("admissions" to) the NYC women's jail for whom syphilis serology results were available.

Methods

The NYC Health Department's STAT program [4] is operated independently of, but in concert with, correctional health services. This program includes use of the rapid qualitative RPR at the time of an inmate's initial medical evaluation to rapidly assess syphilis treatment needs so that inmates needing syphilis treatment can be treated immediately. The STAT program has provided rapid syphilis screening and treatment for ⩾16 of 21 work shifts each week. Evaluation via the STAT program is an adjunct to routine laboratory syphilis serologic analysis. Routine laboratory screening is performed by use of quantitative RPR; reactive RPRs are confirmed by MHP-TP. Only the laboratory data (quantitative RPRs and MHA-TPs) corresponding to specimens used for qualitative RPR screening were used for the analysis presented here.

Specifically, our analysis included women who met each of the following 3 criteria. Criterion 1 was admission ⩾2 times to the NYC women's jail between 24 March 1993 and 10 April 1997. Multiple admissions were identified by use of the fingerprint-based identification codes generated for each subject at her first arrest in New York State. Second, subjects had to undergo admission laboratory serologic testing for syphilis at each admission and, third, had to have results of laboratory-based serologic testing for syphilis available for each admission. Women were included in the analysis only if they met either of the following 2 criteria: (1) quantitative RPR nonreactive on initial admission or (2) serologic evidence of syphilis at baseline (i.e., reactive MHA-TP) coupled with documented appropriate syphilis treatment at the time of baseline incarceration.

Dark-field microscopy was not available at the facility, nor was

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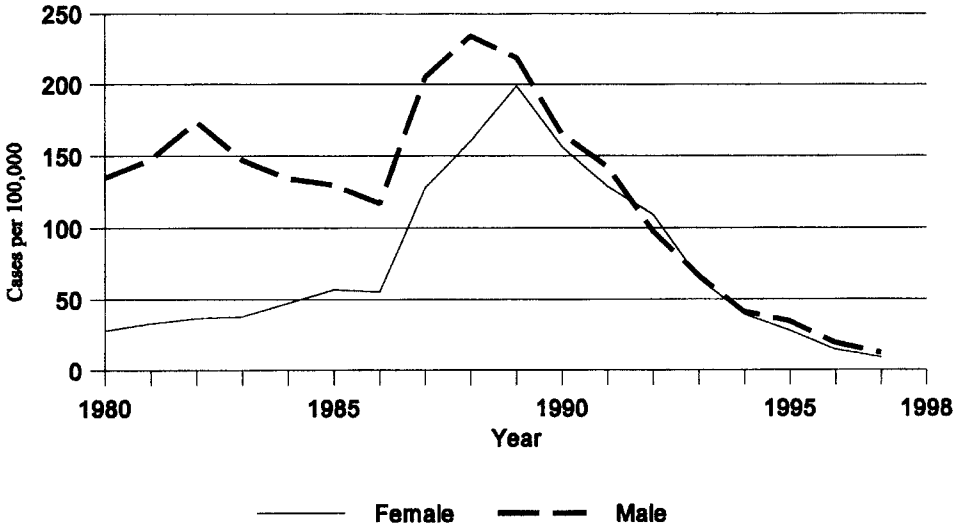

Figure 1. Early syphilis in New York City, 1980–1997, by sex

there clinical information in the database. Only longitudinal serologic data were available to classify infection status.

An "incident infection" was identified as either first infection or reinfection. Women with no serologic evidence of syphilis at initial screening (i.e., baseline RPR nonreactive) who, when subsequently detained, had reactive RPRs and MHA-TPs were defined as having first syphilis infections. We defined a "reinfection" as an increase in the RPR titer by ⩾2 dilutions ⩾1 month after adequate treatment given at the prior admission [6]. We will refer to these definitions of first infection and reinfection as "standard criteria for incident infection." For all 3579 women included in the study, person-time observation was measured from the date of baseline measurement to the last admission prior to 10 April 1997, whether or not incident infection was noted. Theoretically, it was possible for a woman to contribute ⩾1 incident syphilis infections over the study period.

We stratified our analytic group by using available demographic information and estimated the incidence densities by using 2- and 3-stage continuous, time-homogeneous Markov models. A Markov model is a statistical approach that assumes that the instantaneous hazard remains constant over time. By use of this assumption, the appropriate likelihood is constructed and maximized with respect to the parameters of interest, and the observed data are used to estimate these parameters. In addition, SE estimates for the estimated incidence rates are provided by the asymptotic variance-covariance matrix of the maximum likelihood estimates. Confidence intervals (CIs) for the incidence densities are calculated by use of these SEs. Thus, to estimate the overall incidence rate, we used a 2-stage Markov model. The 2 stages were defined as follows: stage 1, no evidence of current infection or evidence of possible current infection with documentation of appropriate treatment; stage 2, subsequent infection. In addition, in order to estimate the incidence rate for different risk factors (e.g., age group and number of admissions), the same 2-stage Markov model was fit to the subset of women with the risk factors of interest.

To differentiate the estimated incidence density of syphilis among women with nonreactive serologies at baseline from that of women with reactive serologies at baseline, we fitted a 3-stage Markov model. The 3 stages were defined as follows: stage 1, no evidence of infection; stage 2, evidence of infection and clearance of infection; and stage 3, reinfected. We also described our analytic group by using available demographic information.

Data collection and descriptions of the study populations were done by use of MS Fox Pro 2.6 (Microsoft, Redmond, WA), Epi Info 6.0 (CDC, Atlanta), and the Statistical Analysis System (SAS, Cary, NC). The Markov models were fitted by use of programs written in Fortran 5.0 (Microsoft).

Last, we reapplied the Markov model using stricter definitions of incident infection to observe the degree to which a stricter case definition altered the incidence density estimates and risk factors. In this supplemental model, referred to as the "stricter criteria," first syphilis infection was defined as a newly reactive RPR titer of ⩾1 : 2 and a reactive MHA-TP. Reinfection was defined as an increase in the quantitative RPR by ⩾3 dilutions ⩾1 month after prior treatment.

Results

Between 24 March 1993 and 10 April 1997, there were ~40,000 admissions to the facility, and all women admitted were laboratory tested for syphilis. In total, routine laboratory syphilis serology results subsequent to STAT testing were available for 18,733 admissions, which represented 14,447 women. Among these women, 3755 (26%) were admitted more than once during the study period. However, of the 3755 women with multiple admissions, 176 (5%) had reactive syphilis serologies at the initial visit, and we could not document adequate treatment for syphilis; thus, they were not included in our analysis. The demographic characteristics of the group of 176 women excluded from the analysis did not differ significantly

from those of the baseline seroreactors for whom treatment data were available. Thus, the exclusion of the group of 176 can reasonably be assumed not to have biased the results.

Of the women with multiple admissions and available serologic results during the study period, 3579 (95%) were included in our analysis. Of the group analyzed, 2719 (76%) were nonseroreactors at the first of at least 2 admissions; 860 (24%) were seroreactors with documented adequate treatment for syphilis at the baseline visit who were readmitted at least once subsequently. Demographic characteristics of women with single admissions and those with multiple admissions who were subject to our analysis are shown in table 1.

Among the 3579 women with multiple admissions included in the analysis, there were 9108 admissions (mean, 2.6/woman). Of these women, 68% ($n = 2427$) had 2 admissions during the observation period, 20% ($n = 713$) had 3, 7% ($n = 262$) had 4, and the remaining 5% ($n = 177$) had 5–13 admissions. Table 2 presents the total person-time observed, based on the number of admissions during the observation period (mean period of observation, 1.3 years; SD, 0.95). The average time between admissions was ~6 months (range, 2 days–3.3 years).

We documented 289 infections among the 3579 women in our analysis. We did not document any person who had >1 incident syphilis infection. The estimated overall incidence rate was 6.5 per 100 woman-years (95% CI, 5.8–7.3). The incident infections included 177 first infections and 112 reinfections. Distribution of titers at diagnosis, determined by use of standard criteria, clustered in the lower range (≤1 : 8) and extended as high as 1 : 1024 (mode, 1 : 4).

The supplementary estimate of incidence, determined by use of the stricter case definitions, resulted in fewer incident infections ($n = 186$) and a lower incidence rate of 4.1 per 100 woman-years (95% CI, 3.6–4.8). Application of the stricter criteria resulted in 131 first infections and 55 reinfections. The incidence densities of these subpopulations, determined by use of the standard and the stricter criteria, are shown in table 3.

Table 1. Comparison of women with multiple and single admissions to the New York City women's jail, 23 March 1993–10 April 1997.

Variable	No. (%) of women with ≥2 admissions (included in analysis)	No. (%) of women with 1 admission (not included in analysis)[a]	P[b]
Race or ethnicity			
White	319 (9)	1099 (10)	
Black	1569 (44)	6327 (58)	
Hispanic	764 (21)	3164 (29)	
Other	164 (5)	138 (1)	
Data missing[c]	763 (21)	140 (1)	
Total (n)	3579	10,868	< .0001
Pregnant at 1st admission			
Yes	233 (6)	680 (6)	
No	3345 (93)	10,093 (93)	
Data missing[c]	1 (<1)	95 (<1)	
Total (n)	3579	10,868	.67

NOTE. Percentages may not add up to 100% because of rounding. The mean ages (±SD) of women with ≥2 or 1 admission(s) were 34.6 ± 7.1 years and 31.9 ± 8.3 years, respectively ($P < .0001$).

[a] Total also includes 176 women with multiple admissions whose treatment status could not be classified.

[b] Two-sample pooled t test was used for the continuous variable, age. χ^2 tests of homogeneity were used for discrete variables.

[c] Missing data were not included in χ^2 tests.

Table 2. Person-time contributions based on the no. of admissions to the New York City women's jail, 23 March 1993–10 April 1997.

No. of admissions	No. of women	No. of woman-days	% total person-time
2	2427	911,729	55
3	713	413,738	25
4	262	179,274	11
≥5	177	156,746	9
Total	3579	1,661,487	100

Discussion

By using the available longitudinal serologic data, we estimated syphilis incidence density among a group of women multiply admitted to the NYC women's jail to be 6.5 infections per 100 woman-years (95% CI, 5.8–7.3). Our finding of a relatively high syphilis incidence density helps explain the persistently high syphilis seroreactivity rates found at the facility over the last several years and documents that these rates do not merely reflect persisting serologic reactivity from previously treated syphilis. Moreover, our finding is consistent with the high prevalence of risk factors for syphilis among NYC women detainees: prostitution, cocaine use, and human immunodeficiency virus (HIV) infection. According to NYC's Correctional Health Services, drug-related charges (including the exchange of sex for drugs or for money to buy drugs) are the most frequent reasons for arrest, occurring among >50% of all women detainees in 1997. In 1993, Holmes et al. [7] reported that 80% of NYC's women detainees had cocaine in their urine at the time of arrest. Importantly, blinded HIV serosurveys have shown that 26% of the women admitted to NYC's only women's jail are infected with HIV [8]. The very high incidence of syphilis and high prevalence of HIV infection identify this institution and population as critical factors for transmission of both diseases in NYC.

Case definitions for classifying incident syphilis are particularly challenging. The absence of history and physical examination data in defining incident infection is clearly an analytic limitation in this investigation and is also a real operational issue in the jail setting. A 4-fold increase in titer after adequate treatment, which we originally defined as reinfection, could potentially represent treatment failures or nonspecific "noise" from other phenomena common to incarcerated populations but for which variables are not contained within our data set (e.g., HIV or tuberculosis). When we developed and applied a supplemental model using stricter criteria, we found a 37% smaller overall incidence rate, which suggests that more noise may occur in the RPR titer than is classically appreciated and also suggests that the definition of incident syph-

Table 3. Selected incidence rates among women with multiple admissions to New York City jails, 23 March 1993–10 April 1997.

Criteria, group	Incidence rate (95% CI)	Rate ratio (95% CI)
Standard[a]		
Overall	6.5 (5.7–7.2)	—
RPR at baseline[b]		
Nonreactive	5.6 (4.8–6.5)	Reference
Reactive	8.0 (7.2–10.4)	1.5 (1.2–1.9)
Age at baseline (years)		
<35	6.6 (5.6–7.7)	Reference
⩾35	6.4 (5.4–7.5)	1.0 (0.8–1.2)
No. of admissions		
2	5.8 (4.9–6.8)	Reference
⩾3	7.4 (6.2–8.6)	1.3 (1.0–1.6)
Stricter[c]		
Overall	4.1 (3.6–4.8)	—
RPR at baseline[b]		
Nonreactive	4.0 (3.4–4.8)	Reference
Reactive	4.4 (3.4–5.7)	1.1 (0.8–1.5)
Age at baseline (years)		
<35	4.0 (3.3–5.0)	Reference
⩾35	4.2 (3.5–5.2)	1.1 (0.8–1.5)
No. of admissions		
2	3.9 (3.2–4.8)	Reference
⩾3	4.4 (3.6–5.5)	1.1 (0.9–1.5)

NOTE. Selected incidence rates were estimated by use of a 2-stage Markov model. Rate ratios were estimated by use of either a 2- or a 3-stage Markov model. CI, confidence interval; RPR, rapid plasma reagin.

[a] Standard criteria for incident infection: first syphilis infection, nonreactive RPR test at baseline, with subsequently reactive RPRs and microhemagglutination–*Treponema palladum* tests (MHA-TPs); syphilis reinfection, increase in RPR titer by ⩾2 dilutions ⩾1 month after prior adequate treatment.

[b] Estimated by use of a 3-stage Markov model.

[c] Stricter criteria for incident infection: first syphilis infection, newly reactive RPR titer of ⩾1 : 2 and reactive MHA-TP; syphilis reinfection, increase in quantitative RPR of ⩾3 dilutions ⩾1 month after prior adequate treatment.

ilis based on increased titers among those with syphilis in the past may have more problems with specificity than with new seroconversion from seronegative status. However, whether or not those who meet the standard criteria represent actual incident infections, we believe that treatment is warranted in these high-risk settings.

Incidence rates were highest among those with ⩾3 admissions during the study period and among those who had reactive RPRs at baseline, although this rate ratio was not statistically significant when the stricter criteria were used ($\alpha = .05$). The rate ratios for women with ⩾3 admissions, compared with those for women with 2 admissions, were not statistically significant by either criterion.

It is informative to compare our overall standard criteria estimate of 6.5 incident cases per 100 woman-years with other local incidence rates. From 1994 to 1997, early syphilis rates in NYC fell from 39.2 to 8.9 cases per 100,000 women. Our estimate of syphilis incidence among women repeatedly jailed at the NYC women's jail exceeds the incidence in the general female population in NYC by 1000-fold. The women's correctional facility has been the source of an increasing proportion of NYC's early syphilis cases. In 1993, 11% of all early syphilis cases among women in NYC were reported from this facility; in 1997, the proportion was 21%.

Furthermore, the incidence densities we estimated (both by standard criteria and by the supplemental model) appear to exceed, by ~10-fold, the 1997 early syphilis rate among women explicitly seeking care for sexually transmitted diseases (STDs) at the NYC Department of Health STD Clinics, which we estimate, from notifiable disease surveillance data, to be 0.5 cases per 100 woman-years. The incidence of syphilis among women with multiple admissions to the NYC women's jail was even higher than that among a subgroup of female injection drug users receiving methadone in NYC during seroconversion to HIV-infected status (1.6/100 person-years) [9], the highest incidence of syphilis in a defined population that we identified in NYC. Furthermore, our estimates exceed published incidence rates measured in STD clinic settings outside NYC [10, 11] and in other high-risk settings [12–14]. However, one must use caution in making such comparisons. Local surveillance data are imperfect, and each published incidence study used different inclusion criteria, laboratory assays, and definitions of first infection and reinfection. Some studies excluded persons with prior histories of syphilis altogether. Nevertheless, these comparisons demonstrate the extraordinarily high incidence of syphilis among women at this facility and document its importance in the control of syphilis in NYC.

Limitations of our analysis may include selection bias, misclassification errors at baseline, and issues of generalizability. We included women evaluated at least twice via the STAT program. Because the STAT program was not operational during all medical intake examinations, the number of admissions we documented does not necessarily reflect all NYC arrests a woman may have had during the study period. Of note, this effect would tend to underestimate the incidence of syphilis in this population. Also, admission patterns are not necessarily evenly distributed across shifts throughout the work week. Although we attempted to include everyone at risk for subsequent syphilis infection, the laboratory's serologic screening algorithm did not include a confirmatory test for a nonreactive RPR assay. It is possible, therefore, that some women were misclassified as susceptible to infection when, in fact, they had prior untreated infections. Consequently, there may be some misclassification of reinfection as first syphilis episode. However, this would not affect our overall estimates of syphilis incidence.

Our findings underscore the need for aggressive and rapid syphilis screening and treatment of women in the correctional setting, particularly since the correctional setting may be the only venue in which many of these women receive health care [15]. Clinicians evaluating inmates for syphilis should maintain a low threshold for treatment, even as community rates decline, especially since incarceration periods characteristic of this and other jails are short (>30% of persons admitted to NYC prisons are released within 2 days), return to the community is almost inevitable, and treatment opportunities after release are few. Treatment during incarceration not only prevents complications of disease in the treated women but also reduces the potential

for the spread of disease both within the facility and in the outside community. Aggressive syphilis control in this population not only interrupts the propagation of syphilis but probably also has a salutary effect on efforts to prevent HIV infection [16, 17]. The extraordinarily high incidence underscores the importance of jails in efforts to eliminate syphilis and to control other communicable diseases.

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