

Prevalence of *Chlamydia trachomatis* Infection Among Men Screened in 4 U.S. Cities

JULIA ANN SCHILLINGER, MD,* EILEEN FRANCES DUNNE, MD,* JOHANNA BEACH CHAPIN, MPH,* JONATHAN MARK ELLEN, MD,† CHARLOTTE ANN GAYDOS, DRPH,† NANCY JO WILLARD, BA,† CHARLOTTE KATHLEEN KENT, MPH,‡ JEANNE MARISA MARRAZZO, MD,§ JEFFREY DAVID KLAUSNER, MD,‡ CORNELIS ARTHUR RIETMEIJER, MD,|| AND LAURI ELLEN MARKOWITZ, MD*

Objective: The objective of this study was to measure the prevalence of *Chlamydia trachomatis* (CT) infection among men in clinical and nonclinical settings across the United States.

Goal: The goal of this study was to obtain data to inform recommendations regarding male CT screening.

Study: The authors conducted a cross-sectional study of CT prevalence among adolescent and adult men in 4 U.S. cities (Baltimore, Denver, San Francisco, and Seattle). CT was detected using urine-based testing, and prevalence was calculated for first testing event.

Results: Over 23,000 men were tested for CT over a 3½-year period. The majority (96%) were asymptomatic. Overall, prevalence was 7% and varied significantly between cities (range: Seattle, 1%; Baltimore, 12%), by age (peak prevalence at age 20–24 years, 9%), and between venues where CT testing was offered.

Conclusions: At 7%, the prevalence of CT is moderately high among men opportunistically tested in nonclinical and clinical settings.

IN THE UNITED STATES, resources to detect and treat *Chlamydia trachomatis* (CT) infections have been directed primarily to screening and treating women, who are at risk for serious sequelae from CT infection, which include pelvic inflammatory disease, ectopic pregnancy, and infertility. Annual CT screening for sexually active 15- to 25-year-old women is recommended by the Centers for Disease Control and Prevention and other agencies.¹ Among men, sequelae from untreated CT infection appear modest, although some sequelae have been suggested by recent research.² Testing males with symptoms of urethritis for CT and treating those found to be infected has long been recommended; however, without evidence that screening asymptomatic men is an effective means of reducing CT disease and sequelae among women, public health agencies have been reluctant to recommend and direct resources to male screening. Because asymp-

From the *Centers for Disease Control and Prevention (CDC), Atlanta, Georgia; †Johns Hopkins University School of Medicine, Baltimore, Maryland; the ‡San Francisco Department of Public Health, San Francisco, California; the §University of Washington, Seattle, Washington; and || Denver Public Health, Denver, Colorado

tomatic men may be an important reservoir of chlamydial infection,³ and the source of many infections and associated sequelae among women, the prevalence of CT infection among asymptomatic men accessible for screening will be a key determinant of the value of a male screening program to women's health.

To date, there have been few reports of large-scale U.S. programs aimed at screening asymptomatic men.^{4,5} The availability and widespread use of urine-based nucleic-acid amplification techniques for the detection of CT has obviated the need to obtain invasive samples and has allowed screening in nonclinical settings where populations at risk for CT are found.^{6,7} To measure the prevalence of CT among men in a variety of venues, we implemented a broad-based male CT testing program using urine testing in 4 U.S. cities. Between October 1999 and April 2003, we tested over 23,000 symptomatic and asymptomatic men for CT in Baltimore, Denver, San Francisco, and Seattle.

Materials and Methods

Urine-based testing for CT was offered to males in juvenile or adult detention facilities, and to males attending adolescent or adult primary care clinics, high school health clinics, college clinics and health fairs, street outreach programs, community-based organizations, or a drug rehabilitation program. For all men, a brief intake form was completed, which included demographic data and questions related to sexual health. Urine specimens were tested for CT using a nucleic acid amplification test (LCR [Abbott Laboratories, Abbott Park, IL], PCR [Roche Diagnostic Systems, Indianapolis, IN], or SDA [Becton Dickinson Diagnostic Systems, Sparks, MD]). Although the type of test used varied between cities, testing was performed at a single laboratory in each city over the period of study. CT-infected men were notified and treated, and efforts were made to notify their sex partners for testing and treatment.

Because some men were tested more than once over the 3½-year study period, we selected the first testing episode for each individual, and estimated CT prevalence for the entire interval, limiting the analysis to men tested in types of venues where at least

The authors thank Jim Braxton, Tom Gift, Alain Joffe, Gerry Waterfield, Shang-en Chung, Stewart Thomas, Laura Lloyd, Lauren Pech, Stuart Cooper, and Toby LeRoux for their work on this project.

This study was funded by a cooperative agreement from the Centers for Disease Control and Prevention (U30/CCU317876; U30/CCU817944; U30/CCU917900) and by Pfizer, Inc.

Correspondence: Julia Ann Schillinger, MD, New York City Department of Health and Mental Hygiene, Bureau of STD Control, 125 Worth Street, CN #73, New York, NY 10013. E-mail: jus8@cdc.gov.

Reprints: Lauri Ellen Markowitz, MD, Division of STD Prevention, National Center for HIV, STD, and TB Prevention, Centers for Disease Control and Prevention, 1600 Clifton Road, NE, Mailstop E-02, Atlanta, GA 30333. E-mail: lem2@cdc.gov.

Received for publication June 28, 2004, and accepted August 10, 2004.

TABLE 1. Prevalence of *Chlamydia trachomatis* Infection Among Men Screened in 4 U.S. Cities (Baltimore, Denver, San Francisco, and Seattle) by Subgroup

Characteristics	No. Tested	Chlamydia-Positive		95% Confidence Intervals
		No.	(%)	
Total	23,507	1548	(7)	(6.7–7.3)
City				
Baltimore	3129	363	(12)	(10.9–13.1)
Denver	3516	345	(10)	(9.0–11.0)
San Francisco	16,097	832	(5)	(4.7–5.3)
Seattle	765	8	(1)	(0.3–1.7)
Age (yrs)				
<15	1371	28	(2)	(1.3–2.7)
15–19	8500	671	(8)	(7.4–8.6)
20–24	5585	498	(9)	(8.2–9.8)
25–29	3872	233	(6)	(5.3–6.7)
30–34	1535	70	(5)	(3.9–6.1)
>34	2577	46	(2)	(1.5–2.5)
Race/ethnicity				
Non-Hispanic white	4431	142	(3)	(2.5–3.5)
Non-Hispanic black	9359	872	(9)	(8.4–9.6)
Hispanic	5861	351	(6)	(5.4–6.6)
Asian/Pacific Islander	1625	73	(4)	(3.9–6.1)
Multirace	437	31	(7)	(4.6–9.4)
Other/Native American/unknown	1794	79	(4)	(3.1–4.9)
Symptoms				
Yes	925	203	(22)	(19.3–24.7)
No	22,582	1345	(6)	(5.7–6.3)
Sex partners in the past 2 mo*				
0	1606	92	(6)	(4.8–7.2)
1	2778	297	(11)	(9.8–12.2)
2	1111	121	(11)	(9.2–12.8)
3–5	972	120	(12)	(10.0–14.0)
≥6	271	37	(14)	(9.9–18.1)
Don't know	22	3	(14)	(–0.5–28.5)
New sex partner in the past 2 mo*				
Yes	2252	306	(12)	(10.7–13.3)
No	4122	370	(9)	(8.1–9.9)
Condom use at last sex with main partner*				
Yes	2860	270	(9)	(8.0–10.0)
No	2451	331	(14)	(12.6–15.4)
Not applicable†	1676	105	(6)	(4.9–7.1)
Condom use at last sex with casual partner*				
Yes	3202	348	(11)	(9.9–12.1)
No	1693	214	(13)	(11.4–14.6)
Not applicable†	1941	134	(7)	(5.9–8.1)
History of chlamydial infection*				
Yes	573	83	(14)	(11.2–16.8)
No	6835	633	(9)	(8.3–9.7)

*Ascertained for men screened in Baltimore, Denver, and Seattle only.

†Participants who did not have a partner of that type.

50 men were tested over the study period. Men who reported discharge or dysuria on the intake form were considered symptomatic. Adolescent or adult primary care, college and school clinics were defined as clinical settings. Patient and venue characteristics were described by univariate analyses; associations with chlamydial infection were assessed using bivariate techniques; *P* values <0.05 were considered statistically significant. All analyses were done using SAS (Statistical Analysis Software version 8; SAS Institute Inc., Cary, NC).

Results

A total of 23,507 men were tested at least once at over 50 different venues in the 4 cities (Table 1). The median age was 21

years. Forty percent of men were of non-Hispanic black race/ethnicity, 25% Hispanic, 19% non-Hispanic white, 7% Asian/Pacific Islanders, and 10% other races. The majority of men tested for CT (96%) were asymptomatic. Men in Baltimore, Denver, and Seattle provided information regarding sex partners, condom use, and history of CT infection. Overall, 65% of men (4384 of 6760) reported 1 or no sex partner in the 60 days before testing.

The overall CT prevalence was 7% and varied by city (Seattle, 1%; San Francisco, 5%; Denver, 10%; Baltimore, 12%). Prevalence was highest among men aged 15 to 19 years (8%) and 20 to 24 years (9%). CT prevalence was substantially higher among symptomatic men (22%) than among asymptomatic men (6%). The prevalence of infection was not significantly higher among

TABLE 2. Prevalence of *Chlamydia trachomatis* Among Symptomatic and Asymptomatic Men Screened in Different Venues, Overall and by City

Venue Type	Overall			Baltimore			Denver			San Francisco			Seattle		
	No. tested	No.	(%)	No. tested	No.	(%)	No. Tested	No.	(%)	No. tested	No.	(%)	No. tested	No.	(%)
All venues	23,507	1548	(7)	3129	363	(12)	3516	345	(10)	16,097	832	(5)	765	8	(1)
Symptomatic	925	203	(22)	290	85	(29)	193	48	(25)	391	69	(18)	51	1	(2)
Asymptomatic	22,582	1345	(6)	2839	278	(10)	3323	297	(9)	15,706	763	(5)	714	7	(1)
Adolescent															
primary care	1084	175	(16)	438	110	(25)	183	31	(17)	408	33	(8)	55	1	(2)
Symptomatic	195	65	(33)	132	49	(37)	27	11	(41)	33	5	(15)	3	0	(0)
Asymptomatic	889	110	(12)	306	61	(20)	156	20	(13)	375	28	(7)	52	1	(2)
Adult primary care	733	60	(8)	N/A	—	—	N/A	—	—	733	60	(8)	N/A	—	—
Symptomatic	140	27	(19)	N/A	—	—	N/A	—	—	140	27	(19)	N/A	—	—
Asymptomatic	593	33	(6)	N/A	—	—	N/A	—	—	593	33	(6)	N/A	—	—
Juvenile detention	4344	243	(6)	N/A	—	—	1778	158	(9)	2,258	78	(3)	308	7	(2)
Symptomatic	147	24	(16)	N/A	—	—	82	19	(23)	18	4	(22)	47	1	(2)
Asymptomatic	4197	219	(5)	N/A	—	—	1,696	139	(8)	2,240	74	(3)	261	6	(2)
Adult detention	11,979	781	(7)	1427	133	(9)	414	56	(14)	10,138	592	(6)	N/A	—	—
Symptomatic	315	51	(16)	110	18	(16)	29	7	(24)	176	26	(15)	N/A	—	—
Asymptomatic	11,664	730	(6)	1317	115	(9)	385	49	(13)	9962	566	(6)	N/A	—	—
School clinic	1729	149	(9)	1264	120	(9)	385	25	(6)	80	4	(5)	N/A	—	—
Symptomatic	68	22	(32)	48	18	(38)	19	4	(21)	1	0	(0)	N/A	—	—
Asymptomatic	1661	127	(8)	1216	102	(8)	366	21	(6)	79	4	(5)	N/A	—	—
Community-based															
organizations	352	41	(12)	N/A	—	—	352	41	(12)	N/A	—	—	N/A	—	—
Symptomatic	20	3	(15)	N/A	—	—	20	3	(15)	N/A	—	—	N/A	—	—
Asymptomatic	332	38	(11)	N/A	—	—	332	38	(11)	N/A	—	—	N/A	—	—
Street outreach	1911	61	(3)	N/A	—	—	296	29	(10)	1615	32	(2)	N/A	—	—
Symptomatic	14	3	(21)	N/A	—	—	13	3	(23)	1	0	(0)	N/A	—	—
Asymptomatic	1897	58	(3)	N/A	—	—	283	26	(9)	1614	32	(2)	N/A	—	—
College clinics	722	25	(3)	N/A	—	—	N/A	—	—	320	25	(8)	402	0	(0)
Symptomatic	22	6	(27)	N/A	—	—	N/A	—	—	21	6	(29)	1	0	(0)
Asymptomatic	700	19	(3)	N/A	—	—	N/A	—	—	299	19	(6)	401	0	(0)
School health fair	545	8	(1)	N/A	—	—	N/A	—	—	545	8	(1)	N/A	—	—
Symptomatic	1	1	(100)	N/A	—	—	N/A	—	—	1	1	(100)	N/A	—	—
Asymptomatic	544	7	(1)	N/A	—	—	N/A	—	—	544	7	(1)	N/A	—	—
Drug treatment	108	5	(5)	N/A	—	—	108	5	(5)	N/A	—	—	N/A	—	—
Symptomatic	3	1	(33)	N/A	—	—	3	1	(33)	N/A	—	—	N/A	—	—
Asymptomatic	105	4	(4)	N/A	—	—	105	4	(4)	N/A	—	—	N/A	—	—

men with multiple sex partners compared with men with only 1 sex partner (11% vs. 12%, $P = 0.26$) or those who had not used a condom at last sex with a casual partner (13% vs. 11%, $P = 0.07$); however, CT prevalence was significantly higher among men who had acquired a new sex partner in the past 2 months (12% vs. 9%, $P < 0.001$), those who had not used a condom at last sex with a main partner (14% vs. 9%, $P < 0.001$), and those who had a history of CT infection (14% vs. 9%, $P < 0.001$).

In all 4 cities, urine-based testing was conducted in at least 1 type of detention setting, either juvenile (Denver, San Francisco, and Seattle) or adult detention (Baltimore, Denver, and San Francisco) (Table 2). Approximately half of all testing (51%; 11,979 of 23,507) occurred in adult detention, the majority of which (85%; 10,138 of 11,979) was conducted in the San Francisco jail system. Testing in juvenile detention accounted for 18% of testing overall. Fifty percent of infections detected over the study period (781 of 1548) were detected in adult detention settings and 16% in juvenile detention. School clinics accounted for 7% of testing (10% of infections detected); street outreach, 8% of testing (4% of infections); adolescent and adult primary care, 8% of testing (15% of infections); and all others, 7% of testing (5% of infections).

Overall, the proportion of men with symptoms was significantly higher at adolescent primary care clinics (18%) and adult primary

care clinics (19%) than at other types of venues ($P < 0.001$), where the proportion of men symptomatic ranged from 0% to 6%. Overall, CT prevalence was significantly higher among men attending adolescent primary care venues than among men in other settings. In Baltimore, the prevalence among asymptomatic men attending adolescent primary care (20%) was significantly higher than the overall prevalence at other venues in that city, whereas the prevalence among asymptomatic men tested in adolescent primary care in Denver (13%) and San Francisco (7%) was similar to the overall prevalence (symptomatic and asymptomatic men together) in several other venues in those cities. In Baltimore and San Francisco, the overall prevalence in school clinics was the same or similar to that measured in adult detention. In Baltimore, Denver, and San Francisco, the prevalence in most venues was markedly higher among symptomatic men compared with asymptomatic men; however, in Seattle, the prevalence was low in all venues, and did not differ for asymptomatic and symptomatic men.

Discussion

With a prevalence of 7% overall, and 6% among asymptomatic men, the prevalence of CT among men in these 4 U.S. cities is comparable to, or somewhat higher than has been reported previ-

ously, and suggests that CT infection is common in asymptomatic men in a number of different settings across the United States. Before this report, the 3 largest surveys of CT prevalence among asymptomatic men in settings other than sexually transmitted disease clinics in the United States were among 2245 men from all 50 states and territories joining the U.S. military⁴; 4968 men in juvenile detention, school-based clinics, and community-based organizations in Seattle, Washington⁵; and 6767 men ages 18 to 26 who participated in the National Longitudinal Study of Adolescent Health, the latter a nationally representative sample of young adults in the United States.⁸ The prevalence of CT infection was less than 5% in all 3 surveys.

In this study, the prevalence varied widely across the cities. This is, in part, the result of the different types of venue where testing was conducted in each city. Differences in prevalence across cities may also reflect geographic differences in disease burden, because chlamydia case rates among women vary by regions of the United States,⁹ and the disease burden among men in the 4 cities (Baltimore, Denver, San Francisco, and Seattle) mirrors the rank order of chlamydial disease rates for women in the same 4 cities.

Not surprisingly, the prevalence of CT infection was higher among symptomatic men (22%) than among asymptomatic men (6%) in virtually all types of venues. However, almost half of symptomatic infections (83 of 203; 41%) were detected among men tested in nonclinical settings. Moreover, only 21% of the 1345 asymptomatic infections were detected in clinical settings. Most of the infections detected by screening would not have been diagnosed without a broad-based screening program, which included nonclinical venues.

Because of wide variation in prevalence at different venues, sexually transmitted disease programs undertaking male screening should identify local venues where men can be feasibly screened and determine the likely yield of screening in those settings. Age criteria may be useful to target screening activities in venues that include men across a broad age range. However, programs contemplating male screening should realize that local CT screening coverage among women may be suboptimal; despite recommendations for annual screening of sexually active 15- to 25-year-old women, at most, only two thirds of sexually active 15- to 19-year-old females in the United States are screened annually for CT.¹⁰

Decisions regarding female screening have been greatly influenced by cost-effectiveness analyses showing that it is cost saving to screen women when CT prevalence is above certain levels.¹¹ Cost-effectiveness analyses of male screening have used the number of sequelae averted among female partners as key parameters in establishing the cost savings of that intervention.^{12,13} Future

cost-effectiveness analyses should also compare the relative value of screening men to reduce sequelae among women with screening a larger proportion of at-risk women.

References

- Centers for Disease Control and Prevention. Sexually transmitted diseases treatment guidelines 2002. *MMWR Morb Mortal Wkly Rep* 2002; 51(No. RR-6):2–34.
- Idahl A, Boman J, Kumlin U, Olofsson JI. Demonstration of *Chlamydia trachomatis* IgG antibodies in the male partner of the infertile couple is correlated with a reduced likelihood of achieving pregnancy. *Hum Reprod* 2004; 19:1121–1126.
- Turner CF, Rogers SM, Miller HG, et al. Untreated gonococcal and chlamydial infection in a probability sample of adults. *JAMA* 2002; 287:726–733.
- Cecil JA, Howell MR, Tawes JJ, et al. Features of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infection in male Army recruits. *J Infect Dis* 2001; 184:1216–1219.
- Marrazzo JM, White CL, Krekeler B, et al. Community-based urine screening for *Chlamydia trachomatis* with a ligase chain reaction assay. *A Intl Med* 1997; 127:796–803.
- Gunn RA, Podschun GD, Fitzgerald S, et al. Screening high-risk adolescent males for *Chlamydia trachomatis* infection. Obtaining urine specimens in the field. *Sex Transm Dis* 1998; 25:49–52.
- Rietmeijer CA, Yamaguchi K, Ortiz CG, et al. Feasibility and yield of screening urine for *Chlamydia trachomatis* by polymerase chain reaction among high-risk male youth in field-based and other non-clinic settings: A new strategy for sexually transmitted disease control. *Sex Transm Dis* 1997; 24:429–435.
- Miller WC, Ford CA, Morris M, et al. Prevalence of chlamydial and gonococcal infections among young adults in the United States. *JAMA* 2004; 291:2229–2236.
- Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance, 2002. Atlanta: US Department of Health and Human Services, Centers for Disease Control and Prevention, September 2003.
- Levine WC, Dicker LW, Devine O, Mosure DJ. Indirect estimation of chlamydia screening coverage using public health surveillance data. *Am J Epidemiol* 2004. In press.
- Howell MR, Quinn TC, Brathwaite W, Gaydos CA. Screening women for *Chlamydia trachomatis* in family planning clinics: The cost-effectiveness of DNA amplification assays. *Sex Transm Dis* 1998; 25:108–117.
- Ginocchio RHS, Veenstra DL, Connell FA, Marrazzo JM. The clinical and economic consequences of screening young men for genital chlamydial infection. *Sex Transm Dis* 2003; 30:99–106.
- Blake DR, Gaydos CA, Quinn TC. Cost effectiveness analysis of screening adolescent males for chlamydia on admission to detention. *Sex Transm Dis* 2004; 31:85–95.