# A School-based Chlamydia Control Program Using DNA Amplification Technology

Deborah A. Cohen, MD, MPH*‡; Malanda Nsuami, MD, MPH*; Roger Bedimo Etame, MD, MSc*; Susanne Tropez-Sims, MD*§; Sue Abdalian, MD‖; Thomas A. Farley, MD, MPH‡; and David H. Martin, MD*

ABSTRACT. *Objectives.* *Chlamydia trachomatis* is the most prevalent bacterial sexually transmitted disease (STD) in the United States, with the highest rates reported among adolescents. Chlamydia has severe consequences including pelvic inflammatory disease and infertility, and is believed to be a cofactor in human immunodeficiency virus transmission. Given that chlamydia is predominantly asymptomatic, most cases are identified through routine screening in health care settings. Over time, screening and treatment appear to be associated with a decrease in the prevalence of disease in areas with consistent chlamydia control programs. The new availability of sensitive and specific urine tests for chlamydia (polymerase chain reaction [PCR] and ligase chain reaction [LCR]) provides the opportunity to screen large numbers of at-risk youth in a noninvasive manner. We used PCR/LCR testing to investigate the feasibility of a school-based chlamydia control program and to determine the prevalence of chlamydia infection among junior and senior high school students.

*Design.* At three junior/senior high schools, all students, regardless of symptoms or sexual history, were given the opportunity to be tested for chlamydia using urine-based PCR or LCR testing. Only students with parental consent were eligible. Parents could not obtain test results, except if their children told them. During the five 3-week testing periods, throughout the day, classes were escorted to the testing area and each student was individually counseled regarding the opportunity to participate in the testing.

*Setting.* Three urban public schools in Louisiana.

*Participants.* A total of 1933 students in grades 7 through 12, including 861 girls and 1072 boys.

*Intervention.* All students were informed about the test and taught about chlamydia during the homeroom period. Students were asked to provide a first-void urine specimen of not more than 30 mL. Specimens were refrigerated and delivered to the laboratory on the same day. Infected students were counseled and offered treatment with azithromycin, 1 g orally. They were also referred for or offered additional STD and human immunodeficiency virus testing. Infected students were asked to refer their sex partners to the city STD clinic for treatment.

*Main Outcome Measure.* Prevalence of *C trachomatis* infection by grade and gender.

*Results.* Parental consent was obtained for 2849 (86.9%) of the 3278 matriculated students in grades 7 through 12. Fifty-one parents (1.6%) returned consent forms refusing permission for their child to participate in this screening and treatment program. The remaining 378 (11.5%) could not be reached by mail or telephone. Among all students with consent, 1933 (67.8% of those consented and 59.0% of those matriculated) were tested. Girls were less likely to be tested than boys (861/1363 [63.2%] vs 1072/1465 [73.2%]).

The overall prevalence of *C trachomatis* was 6.5%, with rates among girls more than twice that of boys (9.7% vs 4.0%). Generally, rates of infection increased with age. The prevalence rates among boys were for 7th grade, 2/208 (1%); 8th grade, 2/196 (2%); 9th grade, 10/236 (4.2%); 10th grade, 12/185 (6.5%); 11th grade, 8/146 (5.5%); and 12th grade, 9/101 (8.9%). For boys 15 to 19 year old, the prevalence of chlamydia was 5.7%. Among girls, the prevalence rates were 7th grade, 0/105 (0%); 8th grade, 11/166 (6.6%); 9th grade, 23/218 (10.6%); 10th grade 23/146 (15.8%); 11th grade, 13/118 (11%); and 12th grade, 13/107 (12.1%). Among girls 15 to 19 years old, 12.7% were infected. Of 126 infected students, treatment was provided to 111 (88%).

For this project, the laboratory cost of LCR testing was $17.76 per test. Without considering clinical staff time to collect the specimens, the average laboratory cost per infected student identified was $272. For students 15 to 19 years of age, of whom 104 (8.9%) of 1170 were infected, the laboratory cost was $200 per case identified.

*Conclusion.* School-based chlamydia screening and treatment is feasible, acceptable, relatively inexpensive, and has a high yield. The higher prevalence among girls might be explained in part by greater incidence of symptoms among boys, prompting earlier diagnosis and treatment. Also, girls may have older, more experienced partners and may have greater exposure to chlamydia early in their sexual lives. The fact that girls are probably more susceptible to infection than boys could play a role as well.

DNA amplification technology as represented by PCR and LCR, the two types of tests currently available, offers the pediatrician who deals with adolescents greater flexibility in diagnosing chlamydia infections. Because the majority of chlamydia infections are asymptomatic and the disease can only be controlled through screening programs, urine-based screening may be the only practical way to accomplish this on a large scale. Schools are settings that can be used to reach the majority of adolescents.

Urine-based screening for chlamydia in school settings should be considered a routine part of programs to con-

trol STDs nationally. Because, over time, screening and treatment appear to be associated with a decrease in the prevalence of disease in areas with consistent chlamydia control programs, a national school-based chlamydia control program conceivably could lead to eradication of endemic *C trachomatis* in the United States. *Pediatrics* 1998;101(1). URL: http://www.pediatrics.org/cgi/content/full/101/1/e1; *chlamydia, school health, polymerase chain reaction, ligase chain reaction, STD control.*

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ABBREVIATIONS. STD, sexually transmitted disease; PCR, polymerase chain reaction; LCR, ligase chain reaction; LE, leukocyte esterase; EIA, enzyme immunoassay.

Infection with *Chlamydia trachomatis* is the most prevalent bacterial sexually transmitted disease (STD) in the United States, with the highest rates reported among adolescents.[1] The long-term consequences of chlamydia infection may be severe, particularly in women; it is estimated that of those infected with chlamydia and not adequately treated, 20% to 40% develop pelvic inflammatory disease.[2] Among those with pelvic inflammatory disease, 20% develop tubal infertility as a result of scarring, 9% experience ectopic pregnancy, and 18% develop chronic pelvic pain.[3] Given that chlamydia is predominantly asymptomatic among as many as 70% to 80% of infected women and 50% of infected men, most cases are identified through routine screening in health care settings.[4–7] Over time, screening and treatment appear to be associated with a decrease in the prevalence of disease in areas with consistent chlamydia control programs.[8,9]

Adolescents are a group considered to be underserved medically. Over the past decade, there has been a burgeoning growth in school-based health clinics to address adolescent health care needs.[10] These clinics are available to respond on a reactive basis to complaints initiated by youth.

A proactive chlamydia screening and treatment program of school-age youth has the potential to identify disease at an early stage, prevent later morbidity, and decrease transmission in the community. The new availability of sensitive and specific urine tests for chlamydia (polymerase chain reaction [PCR] and ligase chain reaction [LCR]) provides the opportunity to screen large numbers of at-risk youth in a noninvasive manner.[11–13]

LCR and PCR are DNA amplification-based diagnostic methods that have been adopted for the detection of *C trachomatis* in clinical specimens. Because these tests theoretically have the potential of detecting a single organism in a specimen, they are highly sensitive. Studies of both LCR and PCR using endocervical specimens in women and urethral specimens in men have shown them to be more sensitive than culture.[14–16] The sensitivity of these assays using urine appears to be at least as sensitive as standard culture methods in both women and men.[14,15,17] The major benefit of DNA amplification tests performed on urine is that for the first time, populations can be screened for *C trachomatis* that were previously inaccessible because of the necessity of performing a pelvic examination in women and obtaining a urethral swab in men.

We developed a chlamydia screening and treatment program using PCR/LCR technology in three inner city junior/senior high schools in Louisiana. All students were African-American and ~70% qualified for the free or reduced lunch program. Although many other programs have conducted chlamydia screening among students seeking medical care,[18] our program was unique in that we attempted to screen all students, regardless of symptoms or sexual history.

## METHODS

All youth in the school were eligible to participate if they had parental consent to receive clinical services in the school-based clinic or if the parents had signed a specific consent allowing the student to participate in the chlamydia screening and treatment program. Consent was obtained in writing or verbally by telephone. During the five 3-week testing periods, throughout the day, classes were escorted to the testing area and each student was individually counseled regarding the opportunity to participate in the testing. Students whose parents had not provided consent were sent back to their classrooms. Students whose parents had provided consent were asked to provide a first-void urine specimen of not more than 30 mL. Leukocyte esterase (LE) testing was performed on samples provided by males, but not used as a guide for treatment purposes. Specimens were refrigerated and delivered to the laboratory on the same day. The first 444 specimens were tested by using the PCR test. Subsequently, the LCR test was used in all patients. The switch from PCR to LCR was done to increase the efficiency of testing in the laboratory. Both tests were performed entirely according to the company's package insert (Amplicor Chlamydia Test, Roche Molecular Systems, Branchburg, NJ and LCX Probe Systems, Abbot Laboratories, Abbot Park, IL).

Infected students were counseled and offered treatment with azithromycin, 1 g orally. They were also referred for or offered additional STD and human immunodeficiency virus testing. Infected students were also asked to refer their sex partners to the city STD clinic for treatment.

We assured all students of confidentiality. All specimens were labeled with a code number. No results were divulged to anyone except to students. Parents could not obtain test results, except if their children told them.

## RESULTS

### Participation

Parental consent was obtained for 2849 (86.9%) of the 3278 matriculated students in the schools. Fifty-one parents (1.6%) returned consent forms refusing permission for their child to participate in this screening and treatment program. The remaining 378 (11.5%) could not be reached by mail or telephone. There were no differences in gender between students with and without consent (Table 1). Consent was obtained from 87.0% of parents of students 15 to 18 years of age and from 87.9% of parents of students <15 years of age. The actual participation rate, however, was lower among students 15 to 18, compared with students <15 (58.1% vs 68.3%). Among all students with consent, 1933 (67.8% of those consented and 59.0% of those matriculated) were tested. Girls were less likely to be tested than boys (861/1363 [63.2%] vs 1072/1465 [73.2%]) (Table 1).

### Infection and Treatment Rates

Of the 1933 students tested, 126 (6.5%) were infected with chlamydia. Girls were 2.4 times as likely

**TABLE 1.** Number and Percent of Students for Whom Consent was Obtained and Testing was Performed*

|  | Matriculated† | Consented (%)‡ | Tested (%)§ |
|---|---|---|---|
| **Sex** | | | |
| Male | 1658 | 1465 (88.4) | 1072 (73.2)‖ |
| Female | 1584 | 1363 (86.0) | 861 (63.2) |
| **Race** | | | |
| African-American | 3278 | 2849 (86.9) | 1933 (59.0) |
| **Age\*** | | | |
| <13 | 130 | 115 (88.5) | 86 (74.8)¶ |
| 13 | 359 | 313 (87.2) | 250 (79.9) |
| 14 | 527 | 463 (87.9) | 358 (77.3) |
| 15 | 598 | 527 (88.1) | 368 (69.8) |
| 16 | 623 | 533 (85.6) | 351 (65.9) |
| 17 | 512 | 446 (87.1) | 288 (64.6) |
| 18 | 305 | 272 (89.2) | 163 (59.9) |
| 19 | 119 | 103 (86.6) | 51 (49.5) |
| >20 | 51 | 46 (90.2) | 15 (32.6) |
| **Grade\*** | | | |
| 7 | 469 | 400 (85.3) | 313 (78.3)¶ |
| 8 | 544 | 473 (86.9) | 362 (76.5) |
| 9 | 806 | 677 (84.0) | 454 (67.1) |
| 10 | 591 | 529 (89.5) | 331 (62.6) |
| 11 | 474 | 422 (89.0) | 264 (62.6) |
| 12 | 393 | 348 (88.5) | 208 (59.8) |

\* Numbers may not equal 100% of total because of missing data.
† Total school population.
‡ Percent of those matriculated.
§ Percent of those consented.
‖ $P < .0001$ for comparing participation between consenting males and females.
¶ $P < .0001$ for linear trend.

to be infected as boys (83/858 [9.7%] vs 42/1071 [4.0%] in boys; $P < .001$). Rates among girls increased from 6.6% in 8th grade to 15.8% in 10th grade and were slightly lower thereafter (Fig 1). Rates rose steadily in boys from 1% in 7th graders to 8.9% among 12th graders. Of 126 infected students, treatment was provided to 111 (88%). Of the 15 students not treated, 7 had dropped out of school, 1 was treated the following year, 3 were negative on retest and presumably had been treated elsewhere, and 4

could not be located even though they still were enrolled in school.

The sensitivity and specificity of LE testing performed for males only, using PCR and LCR as the standard, were 73.8% (31/42) and 85.6% (870/1016), respectively. The positive predictive value of the LE test was 17.5% (31/177).

### Cost

For this project, the laboratory cost of LCR testing was $17.76 per test. Without considering clinical staff time to collect the specimens, the average laboratory cost per infected student identified was $272. For students 15 to 19 years of age, of whom 104 (8.9%) of 1170 were infected, the laboratory cost was $200 per case identified. Among the girls 15 to 19 years of age, 68 (12.7%) of 536 were infected, lowering the cost to $140 per case; among the boys, 36 (5.7%) of 634 were infected, and the laboratory cost was $313 per case identified.

### COMMENT

We found that school-based chlamydia screening and treatment are feasible, acceptable, and relatively inexpensive, and has a high yield. A limitation on the interpretation of our data is that only 59% of the students enrolled were tested. We cannot be sure that the students not tested did not have a higher or lower rate of infection than those tested. However, even if all other students not tested were uninfected, the minimum prevalence of *C trachomatis* in this population would be 3.9%. The prevalence of 9.7% for all girls, 12.7% for girls age 15 to 19, 4% for all boys, and 5.7% for boys age 15 to 19 is quite high, exceeding that reported in many studies in which all patients are sexually active. Studies have reported prevalence rates of 5.9% among women attending STD and family planning clinics,[12] 9% among pregnant women in rural settings,[19] and 8.2% among active-duty army females.[20] The prevalence of chlamydia infection



**Fig 1.** Prevalence of chlamydia by grade and gender.
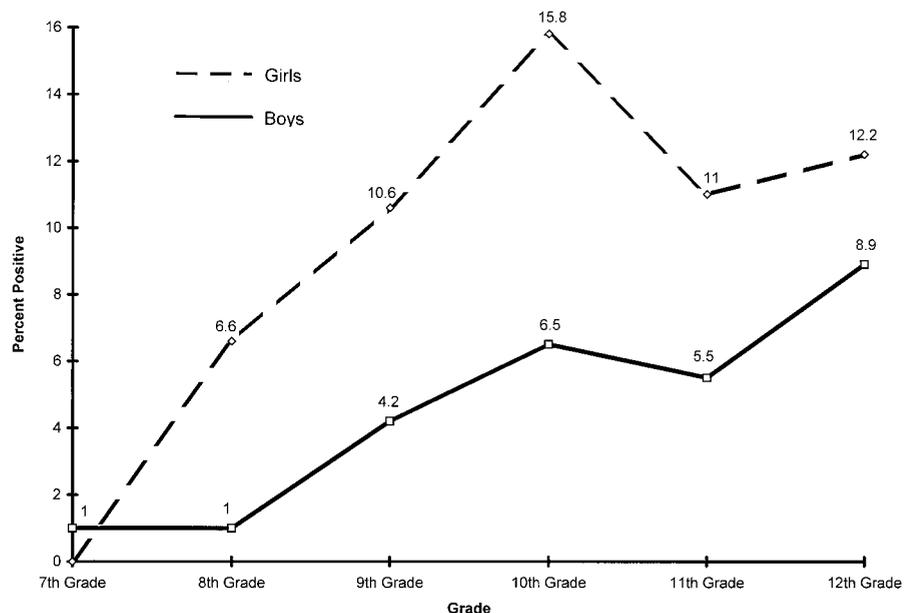
among adolescent girls 15 to 19 years of age seen in New Orleans family planning clinics is 11.5%.[21] *C trachomatis* prevalence rates of 20% to 30% have been reported in pregnant adolescent girls.[22,23] Among males seen in teen clinics, detention centers, military clinics, and colleges clinics, chlamydia prevalence has been found to be 7%.[24] Another study of males in a primary care setting found a prevalence of only 1%.[25] The Youth Risk Behavior Survey of high school students in New Orleans, conducted by Centers for Disease Control and Prevention, has shown that 52.4% of girls and 77.6% of boys admitted to ever having sex.[26] If only the sexually active youth were used as the denominator, infection rates reported here would have been significantly higher.

There are a number of possible reasons for girls having higher rates of infection and lower participation than boys. The higher prevalence of infection might be explained in part by greater incidence of symptoms among boys, prompting earlier diagnosis and treatment. Also, girls are likely to have older, more experienced partners and may have greater exposure to chlamydia early in their sexual lives.[27,28] The fact that girls are probably more susceptible to infection than boys could play a role as well.[29] Although we stressed that universal participation would protect everyone's confidentiality, some students refused on the grounds that they were not sexually active and would not be at risk for chlamydia. That girls were less likely to accept the test compared with boys may be a reflection of girls' reluctance to be seen as sexually active. On the other hand, boys may have wanted to be tested so as to appear sexually active, even if they were not. Older students were less likely to be tested, probably because the absentee rate was higher in this group than among younger students. Some of the older girls refused to participate because they said they were already enrolled at family planning or prenatal clinics and had been tested recently. Thus, selection bias could explain the lower rates among 11th and 12th grade girls, compared with 10th grade girls.

The laboratory costs of our program compare favorably with the laboratory costs required to test asymptomatic males using LE and/or enzyme immunoassay (EIA). Shafer and coworkers[24] reported a laboratory cost of $434 using EIA to identify a case in a population with a prevalence of 7%. The use of LE followed by EIA brought the laboratory cost down to $192. In our male population, LE would have missed 26% of the cases. LE screening has a low sensitivity and predictive value in females, and its use is not recommended.[30] In contrast to EIA, a major advantage of urine LCR is that special facilities are not necessary to perform physical examinations, allowing chlamydia screening and treatment programs to be carried out in nonclinical settings, including schools that do not have dedicated school health clinics.

No sexual behavior data were collected in this project because of state legal restrictions. Such data, including the onset and frequency of sexual activity, age and sociodemographics of sexual partners, history of STD, and reproductive health services use,

would be important in defining further the epidemiology of *C trachomatis* infection in this student population.

DNA amplification technology as represented by PCR and LCR, the two types of tests currently available, offers the pediatrician who treats adolescents greater flexibility in diagnosing chlamydia infections. In symptomatic girls in whom a pelvic examination is indicated and in symptomatic boys in whom a urethral swab can be justified, the best diagnostic specimens remain endocervical and urethral secretions, respectively, obtained by direct swabbing. However, there are many asymptomatic sexually active adolescents in whom screening is important, but it is not possible to perform an optimal examination. Both PCR and LCR have adequate sensitivity for the detection of chlamydial infections in both boys and girls.[31]

Considering the high rate of sexual activity among junior and senior high school youth, the high rates of asymptomatic chlamydia transmission, and the relative ease of screening and treating large numbers of youth, school-based screening in inner-city schools is likely to be cost-effective.

Screening programs should be attempted in schools not in inner-city areas to determine whether the yield would be as high and would justify routine school-based screening as part of all STD control programs. Although it seems likely that school-system-wide screening and treatment for *C trachomatis*, at least in high prevalence areas, would lower the community incidence of infection and the long-term sequelae of chlamydial infection, a community-level controlled trial will be necessary to answer definitively these questions. If, in fact, it can be demonstrated clearly that repeated school-based screening and treatment has such an effect, a national program conceivably could lead to eradication of endemic *C trachomatis* in the United States.

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