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Ability of New APTIMA CT and APTIMA GC Assays To Detect *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in Male Urine and Urethral Swabs

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A clinical evaluation was conducted in six North American centers to determine the ability of APTIMA CT (ACT) and APTIMA GC (AGC) nucleic acid amplification assays to detect *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections in 1,322 men by testing their urethral swabs and first-catch urine (FCU). The results obtained with ACT and AGC assays were compared to an infected patient status determined by testing the specimens with the APTIMA Combo 2 and the BD ProbeTec energy transfer multiplex assays. Symptoms did not influence the values. Positive and negative agreements of the ACT and AGC assays for individual specimens were high, with each comparator assay ranging between 94.3 and 100% for positives and 93.9 and 99.4% for negatives. The ACT and AGC assays performed on noninvasive specimens such as FCU effectively identified *C. trachomatis* or *N. gonorrhoeae* infections in symptomatic and asymptomatic men and should be suitable for screening male populations.

Infection of the lower genital tracts of men and women with *Chlamydia trachomatis* or *Neisseria gonorrhoeae* is a common occurrence worldwide. Most of these infections occur in sexually active younger patients without symptoms of urethritis or cervicitis (2). Undiagnosed and untreated infections lead to epidemic spread and a high risk of bacterial invasion of the upper genital tract. Upper genital tract infections in women are characterized by pelvic inflammatory disease, ectopic pregnancy, and tubal infertility. Traditional sampling of men involved collection of a urethral swab (US). Many infected men are asymptomatic (18, 21). Asymptomatic men are unlikely to consent to collection of invasive swabs. An advance in male testing was achieved by the recognition that first-void (catch) urine (FCU) samples tested in nucleic acid amplification (NAA) assays could identify *C. trachomatis* and *N. gonorrhoeae* infections in as many symptomatic and asymptomatic men as urethral swabbing could (3). All of the present commercial NAA tests have a claim for testing male urine, and in many settings this has become the standard of practice for diagnosing male infections.

Because of the very high asymptomatic infection rates in both genders, there is great interest in establishing screening programs in select populations (12, 16, 20). Gen-Probe Incorporated has recently introduced a new family of assays (APTIMA) that uses their transcription-mediated amplification (TMA) technology. These assays include the APTIMA CT (ACT) assay, which detects *C. trachomatis*; the APTIMA GC (AGC) assay for detecting *N. gonorrhoeae*; and the APTIMA Combo 2 (AC2) assay, which detects both organisms. They are second-generation NAA tests that utilize target capture, TMA, and hybridization protection assay technologies to remove potential inhibitors from samples, amplify target rRNA, and detect amplicons, respectively. The ACT and AGC use oligonucleotides that target rRNA sequences different from those of the AC2, but the procedures for the three assays are the same.

We conducted a prospective multicenter study to determine the performance of the ACT and AGC assays in comparison to the AC2 assay and the BD ProbeTec (PT) energy transfer amplified DNA assay for *C. trachomatis* and *N. gonorrhoeae* (Becton Dickinson Bioscience, Sparks, Md.) on USs and FCU from men.

MATERIALS AND METHODS

Patients. We enrolled 1,322 men between the ages of 15 and 77 years (mean age, 28.5 years) from six clinical sites in North America: Hamilton, Ontario, Canada; New Orleans, La.; Birmingham, Ala.; Jacksonville, Fla.; Pittsburgh, Pa.; and San Francisco, Calif. (Table 1). Patients enrolled at these sexually transmitted disease clinics signed or gave oral consent to an investigational review board-approved protocol and consent form. Where appropriate, each site adhered to standards to show compliance with the Health Insurance Portability and Accountability Act.

Subjects were classified as symptomatic if symptoms such as discharge or dysuria were reported by the subject. Asymptomatic status was assigned to those patients who did not report symptoms regardless of any signs detected by the clinician during examination. Subjects were eliminated from enrollment in the study if they could not concurrently provide an FCU of the first 25 ml of micturition and two physician-collected USs, if they had urinated within 1 h, if they had taken antibiotics within the last 21 days, or if they could not provide a valid informed consent. Patients were enrolled from October 2002 to January 2003.

Specimen collection, transport, storage, and testing. Two USs and one FCU specimen were collected from each patient. One of the swabs and an aliquot of

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TABLE 1. Prevalence, sensitivity, specificity, and predictive values for the APTIMA CT and APTIMA GC assays performed on US and FCU for the six study sites to detect *C. trachomatis* and *N. gonorrhoeae*

Type of value[b]	Sample	CT/GC value for study site[a]:						
		HAM	SAN	JAX	NOR	PIT	BIR	All
Prevalence (%)		6.0/4.0	5.8/5.8	24.2/21.4	25.1/20.0	25.0/0	20.5/12.8	17.9/13.9
Sensitivity (%)	US	100/100	100/100	98.4/100	94.4/98.6	100/NA[c]	100/100	97.5/99.5
	FCU	100/100	100/100	98.4/100	97.8/97.1	100/NA	90.2/100	96.2/98.9
Specificity (%)	US	97.9/98.4	100/100	95.8/100	94.7/97.8	97.1/100	96.7/98.1	96.9/97.3
	FCU	97.9/98.4	99.5/100	98.4/100	97.4/98.9	100/NA	97.5/99.2	98.1/99.3
PPV (%)	US	75.0/72.7	100/100	88.2/100	85.7/75.0	76.9/NA	88.4/88.6	87.1/85.4
	FCU	75.0/98.4	92.3/100	95.2/100	92.6/98.9	100/100	90.2/99.2	91.5/95.8
NPV (%)	US	100/100	100/100	98.0/100	98.0/99.6	100/100	100/100	99.4/99.9
	FCU	100/72.7	100/100	99.5/100	99.2/95.8	100/NA	97.5/95.1	99.2/99.8
No. of subjects		200	207	252	354	4	305	1,322

[a] CT, *C. trachomatis;* GC, *N. gonorrhoeae;* HAM, Hamilton; SAN, San Francisco; JAX, Jacksonville; NOR, New Orleans; BIR, Birmingham; PIT, Pittsburgh.
[b] PPV, positive predictive value; NPV, negative predictive value.
[c] NA, not applicable.

FCU were tested by ACT, AGC, and AC2. The other US and an aliquot of FCU were tested by the PT assay. Collection, transportation, and testing followed the procedures described in the package inserts (8, 25). Enrollment and ACT, AC2, AGC, and PT testing were performed at Hamilton, New Orleans, and San Francisco. Pittsburgh, Birmingham, and Jacksonville performed enrollment and ACT, AGC, and AC2 testing. Wishard Memorial Hospital in Indianapolis, Ind., performed PT testing only for these latter three sites. Specimens were stored at 4°C and shipped on wet ice.

Assays. For the APTIMA assays swab or urine specimens were collected and transferred into AC2 assay transport medium. The transport solutions in these tubes released the rRNA targets and protected them from degradation during storage. The target rRNA molecules were isolated from the urine or swab samples by the use of a target capture method with capture oligomers on magnetic microparticles. The capture oligomers contain sequences complementary to specific regions of the target molecules as well as a string of deoxyadenosine residues. During the hybridization step the sequence-specific regions of the capture oligomers attached to specific regions of the target molecules. The oligomer-target complex was then captured out of solution by decreasing the temperature of the reaction. This temperature reduction allowed hybridization to occur between the deoxyadenosine region on the capture oligomer and the polydeoxythymidine molecules that are covalently attached to the magnetic particles. The microparticles, including the captured target molecules bound to them, were pulled to the side of the reaction vessel by using magnets, and the fluid was aspirated. The particles were washed to remove residual specimen matrix that may have contained amplification reaction inhibitors. The TMA reaction replicated a specific region of the *C. trachomatis* and *N. gonorrhoeae* rRNAs. A unique set of primers was used for each target molecule. Detection of the rRNA amplification product sequences (amplicon) was achieved using the hybridization protection assay technique. Single-stranded chemiluminescent DNA probes, which are complementary to a region of the target amplicon and labeled with acridinium ester molecules, combined with amplicon to form stable RNA-DNA hybrids. The selection reagent differentiated hybridized from unhybridized probe, eliminating the generation of signal from unhybridized probe. During the detection step, light emitted from the labeled RNA-DNA hybrids was measured as photon signals in a luminometer and is reported as relative light units. The AC2 and PT assays are U.S. Food and Drug Administration (FDA) cleared, and an explanation of their technologies is available in their package inserts and as publications (8, 25).

Data management and analysis. ACT and AGC assay results from USs and FCU were compared to infected patient status (IPS) for determining sensitivity, specificity, and predictive values with 95% confidence intervals by using the exact binomial distribution method. A patient was considered infected if both of the specimen types were positive in at least one of the FDA-cleared tests (AC2 or PT) or if at least one of the two specimen types was positive in both AC2 and PT tests. Equivalent performance was determined by calculating percent positive and negative agreement of the ACT and AGC assay results with each of the other two assays from the same specimen type. Prevalence was calculated overall and for each study site based on IPS.

RESULTS

A total of 1,322 patients were enrolled in the study from the six sites. Non-Hispanic blacks represented 62.2% and whites represented 24.6% of the subjects. A total of 236 patients were infected with *C. trachomatis* and 183 were infected with *N. gonorrhoeae* according to the IPS algorithm. Symptoms were reported in 59.7% (141 of 236) of infected and 40% (435 of 1,086) of uninfected men. Table 1 summarizes the numbers of patients enrolled at each study site and shows the prevalences, sensitivities, specificities, and predictive values for US and FCU. There were 236 men with *C. trachomatis* (prevalence, 17.9%) and 183 men with *N. gonorrhoeae* (prevalence, 13.9%) infections. Hamilton and San Francisco were low-prevalence sites for *C. trachomatis* and *N. gonorrhoeae*, and the others were of high prevalence, except for Pittsburgh, where the number of subjects enrolled was too small to allow meaningful calculations. Regardless of the prevalences, the ACT and AGC assays performed similarly, as sensitivity and specificity ranges were tight across sites and from one specimen type to the other. The respective ACT and AGC assay sensitivities were 96.2 and 98.9% for FCU and 97.5 and 99.5% for US; specificities ranged from 96.9 to 99.3%. The one exception for the ACT assay was at the Birmingham site, where the result with FCU was 9.8% less sensitive than for the swab specimen. All of the sites approached 100% sensitivity for the AGC assay on US and FCU. Specificities of both assays and both specimen types were also high (96.9 to 99.3%).

The sensitivities and specificities of the assays performed on US and FCU on symptomatic and asymptomatic patients are presented in Tables 2 and 3. Both specimen types showed high sensitivity and specificity in symptomatic and asymptomatic patients for *C. trachomatis* and *N. gonorrhoeae*. An equal or higher sensitivity and specificity were achieved in asymptomatic patients infected with *C. trachomatis* by testing US or

TABLE 2. Sensitivity and specificity of the ACT assay performed on USs and FCU according to presence (+) or absence (−) of symptoms

Specimen	Presence of symptoms	Sensitivity			Specificity		
		%	No. identified/ no. total	95% CI[a]	%	No. identified/ no. total	95% CI[a]
US	+	96.5	136/141	91.9–98.8	95.9	417/435	93.5–97.5
	−	98.9	94/95	94.3–100	97.5	634/650	96.0–98.6
	Both	97.5	230/236	94.5–99.1	96.9	1,051/1,085	95.6–97.8
FCU	+	94.3	133/141	89.1–97.5	98.2	427/435	96.4–99.2
	−	98.9	94/95	94.3–100	98	638/657	96.6–98.9
	Both	96.2	227/236	92.9–98.2	98.1	1,065/1,086	97.1–98.8

[a] CI, confidence interval.

FCU. In patients infected with *N. gonorrhoeae*, the FCU specimen appeared to be more effective in symptomatic men.

Table 4 shows a calculation of agreement of the ACT and AGC results compared to those from the AC2 and PT assays for US and FCU. Percent agreement between positive results from ACT and AC2 was 97.6% (240 of 246) for US and 96.6% (227 of 235) for FCU. Positive and negative agreements between the assays and for the two specimen types ranged from 94.3 to 100% and 93.9 to 99.3%, respectively. These ranges were not significantly different, as evidenced by the overlapping 95% confidence intervals. When the data were stratified by symptoms, the agreements remained similar for *C. trachomatis*. *N. gonorrhoeae* positive agreement was 10% less between AGC and PT in asymptomatic subjects (data not shown).

DISCUSSION

The ACT and AGC assays demonstrated excellent sensitivity and specificity on US and FCU compared to the FDA-cleared assays, AC2 and PT, to identify infected men. This high performance on a noninvasive specimen such as FCU from asymptomatic men adds this test to a growing list of NAA assays (1, 3, 4, 6–9, 11, 14, 15, 17, 19, 20, 22–25) which could be used for screening urine from men.

The sensitivity and specificity performance of these new assays, based on an expanded reference standard of IPS, was high and generally similar across the six study sites. Positive and negative predictive values for FCU and US were also similar across sites. This observation should enable the screening of men by testing their urine in these tests. This strategy for the control of *C. trachomatis* and *N. gonorrhoeae* infections in high-risk male youth has already been shown to be successful in clinic and nonclinic settings by testing FCU by PCR (20).

Using an expanded reference standard to determine the ability of an assay performed on a specific specimen type to detect an infected patient (10) has become standard procedure for comparing different assays. The strategy provides more infected patients than those determined by a single specimen type. It also allows a better comparison of the utility of each to diagnose patients who will need treatment. Overall both US and FCU identified similar numbers of infected men. The US identified three more *C. trachomatis*-infected men with symptoms than FCU did, but the same numbers ($n = 94$) of asymptomatic men were identified as positive by testing FCU and US. The same number of *N. gonorrhoeae*-infected men with symptoms were identified by both specimen types, and US identified one more infected asymptomatic man than FCU did. The sensitivity and specificity of the ACT test were 97.5 and 96.9% for US and 96.2 and 98.1% for FCU, respectively. Similarly the sensitivities and specificities in the AGC assay were 99.5 and 97.3% for US and 98.9 and 99.3% for FCU, respectively. Differences were minimal between the sensitivities in the symptomatic and asymptomatic groups with FCU, but the AGC assay on FCU detected fewer cases of *N. gonorrhoeae* infection than US did (Table 3). More studies are required to determine the validity of this observation.

The multicenter trials using the PT assay (25) showed sensitivity rates of 93.1% for FCU and 92.5% for US, but both specimen types showed a reduced sensitivity rate of 85.7% in asymptomatic patients. The specificity of the PT *C. trachomatis* assay in that study, which used ligase chain reaction (LCR) and culture to provide IPS, was also much lower at 93.8%. Studies

TABLE 3. Sensitivity and specificity of the AGC assay performed on USs and FCU according to presence (+) or absence (−) of symptoms

Specimen	Presence of symptoms	Sensitivity			Specificity		
		%	No. identified/ no. total	95% CI[a]	%	No. identified/ no. total	95% CI[a]
US	+	99.4	171/172	96.8–100	97.5	393/403	95.5–98.8
	−	100	110/110	71.5–100	97.1	710/731	95.6–98.2
	Both	99.5	182/183	97.0–100	97.3	1,103/1,134	96.1–98.1
FCU	+	99.4	171/172	96.8–100	99	400/404	97.5–99.7
	−	90.9	100/110	58.7–99.8	99.5	730/734	98.6–99.9
	Both	98.9	181/183	96.1–99.9	99.3	1,130/1,138	98.6–99.7

[a] CI, confidence interval.

TABLE 4. Agreement of ACT and AGC assay results for USs and FCU with outcomes achieved by AC2 and PT assays

Tests and outcome	US			FCU		
	No. of samples	% Agreement (95% CI[a])		No. of samples	% Agreement (95% CI[a])	
		Positive	Negative		Positive	Negative
ACT/AC2		97.6 (98.4–99.1)	97.8 (96.7–98.6)		96.6 (93.4–98.5)	98.1 (97.1–98.8)
+/+	240			227		
+/−	24			21		
−/+	6			8		
−/−	1,051			1,056		
AGC/AC2		99 (96.4–99.9)	99.3 (98.6–99.7)		99.4 (97.0–100)	99.2 (98.5–99.6)
+/+	198			180		
+/−	8			9		
−/+	2			1		
−/−	1,100			1,131		
ACT/PT		100 (98.1–100)	93.9 (92.3–95.2)		94.3 (90.3–97.0)	95.8 (94.5–96.9)
+/+	194			200		
+/−	69			46		
−/+	0			12		
−/−	1,055			1,055		
AGC/PT		98.4 (95.3–99.7)	97.1 (95.9–98.0)		97.8 (94.4–99.4)	98.9 (98.0–99.4)
+/+	180			176		
+/−	33			13		
−/+	3			4		
−/−	1,099			1,118		

[a] CI, confidence interval.

evaluating LCR for *C. trachomatis* (3) and PCR (24) and the AC2 assay for *C. trachomatis* and *N. gonorrhoeae* (8) have shown sensitivity rates for US and FCU ranging from 92 to 98% and specificity rates of 98 to 100% regardless of symptoms. FCU rates were usually slightly lower than US rates, which may be due to urinary inhibition. Inhibition has been described in urine for LCR, PCR, and the original TMA assays (13). However, specimen processing and the concentration of *C. trachomatis* added as a control to show the presence of inhibitors have been shown to influence false-negative rates in the LCR assay, and inhibitors were shown not to play a role in the AC2 assay, the analytical sensitivity of which was the detection of one elementary body (5). The ACT and AGC assays combine the same technology of target capture, hybridization protection, and TMA. By using magnets, the particles are washed to remove residual specimen matrix, which may contain inhibitors. This technology may contribute to greater sensitivity.

Overall there were 34 US and 21 FCU specimens that were considered false positive in the ACT assay according to IPS in the calculations for Table 2. An analysis of these specimens showed that 15 (44.1%) of the US and 3 (14.3%) of the FCU specimens may have been true positives as they were also positive in the AC2 test. A similar assessment of the six US and nine FCU specimens considered false negative showed that four (66.6%) of the former and two (22.2%) of the latter were negative in the AC2 assay. From the calculations shown in Table 3, one US and two FCU specimens were falsely positive in the AGC test by the IPS algorithm. The US was positive and the two FCU specimens were negative in the AC2 test. Of the 23 USs considered false positive in the AGC assay, eight were positive in the AC2 test. One of eight falsely positive FCU specimens in the AGC assay was positive by AC2.

Because this study performed AC2 and PT tests on all of the specimens from each patient, it allowed the determination of IPS by using two FDA-cleared assays and also provided an opportunity to calculate agreement for each specimen type. Table 4 shows that, for FCU, the ACT and AGC test results agreed with the PT results on the majority of the positives and negatives. Similarly, agreement was high with AC2 positives and negatives. Calculations of 95% confidence intervals for each paired-specimen comparison indicated no statistically significant differences between specimen types when the data were stratified by symptom status (data not shown).

In conclusion, the new ACT and AGC assays performed very well on US and FCU specimens from men in six centers in North America. *C. trachomatis*-infected men without symptoms were detected equally as well as those with symptoms. This combination of high sensitivity and specificity on noninvasive specimens should enable the implementation of male screening programs for the diagnosis and treatment of *C. trachomatis* and *N. gonorrhoeae*.

REFERENCES

1. **Bauwens, J. E., A. M. Clark, M. J. Loeffelholz, S. A. Herman, and W. E. Stamm.** 1993. Diagnosis of *Chlamydia trachomatis* urethritis in men by polymerase chain reaction assay of first-catch urine. J. Clin. Microbiol. **31:**3013–3016.
2. **Cates, W., and J. N. Wasserheit.** 1991. Genital chlamydia infections: epidemiology and reproductive sequelae. Am. J. Obstet. Gynecol. **164:**1771–1781.
3. **Chernesky, M., H. Lee, J. Schachter, J. D. Burczak, W. E. Stamm, W. M. McCormack, and T. C. Quinn.** 1994. Diagnosis of *Chlamydia trachomatis* urethral infection in symptomatic and asymptomatic men by testing first-void urine in a ligase chain reaction assay. J. Infect. Dis. **170:**1308–1311.
4. **Chernesky, M. A., S. Chong, D. Jang, K. Luinstra, J. Sellors, and J. B. Mahony.** 1997. Ability of commercial ligase chain reaction and PCR assays to diagnose *Chlamydia trachomatis* infections in men by testing first-void urine. J. Clin. Microbiol. **35:**982–984.
5. **Chong, S., D. Jang, X. Song, J. Mahony, A. Petrich, P. Barriga, and M. Chernesky.** 2003. Specimen processing and concentration of *Chlamydia trachomatis* added can influence false-negative rates in the LCx assay but not in

the APTIMA Combo 2 assay when testing for inhibitors. J. Clin. Microbiol. **41:**778–782.

6. **Domeika, M., M. Bassiri, and P.-A. Mårdh.** 1994. Diagnosis of genital *Chlamydia trachomatis* infections in asymptomatic males by testing urine by PCR. J. Clin. Microbiol. **32:**2350–2352.
7. **Ferrero, D. V., H. N. Meyers, D. E. Schultz, and S. A. Willis.** 1998. Performance of the Gen-Probe AMPLIFIED Chlamydia trachomatis assay in detecting *Chlamydia trachomatis* in endocervical and urine specimens from women and urethral and urine specimens from men attending sexually transmitted disease and family planning clinics. J. Clin. Microbiol. **36:**3230–3233.
8. **Gaydos, C. A., T. C. Quinn, D. Willis, A. Weissfeld, E. W. Hook, D. H. Martin, D. V. Ferrero, and J. Schachter.** 2003. Performance of the APTIMA Combo 2 assay for detection of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in female urine and endocervical swab specimens. J. Clin. Microbiol. **41:**304–309.
9. **Goessens, W. H. F., J. W. Mouton, W. I. van der Meijden, S. Deelen, T. H. van Rijsoort-Vos, N. Lemmens-den Toom, H. A. Verbrugh, and R. P. Verkooyen.** 1997. Comparison of three commercially available amplification assays, AMP CT, LCx, and COBAS AMPLICOR, for detection of *Chlamydia trachomatis* in first-void urine. J. Clin. Microbiol. **35:**2628–2633.
10. **Jang, D., J. W. Sellors, J. B. Mahony, L. Pickard, and M. A. Chernesky.** 1992. Effects of broadening the gold standard on the performance of a chemiluminometric immunoassay to detect *Chlamydia trachomatis* antigens in centrifuged first void urine and urethral swab samples from men. Sex. Transm. Dis. **19:**315–319.
11. **Jaschek, G., C. A. Gaydos., L. E. Welsh, and T. C. Quinn.** 1993. Direct detection of *Chlamydia trachomatis* in urine specimens from symptomatic and asymptomatic men by using a rapid polymerase chain reaction assay. J. Clin. Microbiol. **31:**1209–1212.
12. **Kent, C. K., A. Branzuela, L. Fischer, T. Bascom, and J. D. Klausner.** 2002. Chlamydia and gonorrhea screening in San Francisco high schools. Sex. Transm. Dis. **29:**373–375.
13. **Mahony, J., S. Chong, D. Jang, K. Luinstra, M. Faught, D. Dalby, J. Sellors, and M. Chernesky.** 1998. Urine specimens from pregnant and nonpregnant women inhibitory to amplification of *Chlamydia trachomatis* nucleic acid by PCR, ligase chain reaction, and transcription-mediated amplification: identification of urinary substances associated with inhibition and removal of inhibitory activity. J. Clin. Microbiol. **36:**3122–3126.
14. **Martin, D. H., C. Cammarata, B. Van Der Pol, R. B. Jones, T. C. Quinn, C. A. Gaydos, K. Crotchfelt, J. Schachter, J. Moncada, D. Jungkind, B. Turner, and C. Peyton.** 2000. Multicenter evaluation of AMPLICOR and automated COBAS AMPLICOR CT/NG tests for *Neisseria gonorrhoeae*. J. Clin. Microbiol. **38:**3544–3549.
15. **Moncada, J., J. Schachter, M. A. Shafter, E. Williams, L. Gourlay, B. Lavin, and G. Bolan.** 1994. Detection of *Chlamydia trachomatis* in first catch urine samples from symptomatic and asymptomatic males. Sex. Transm. Dis. **21:** 8–12.
16. **Monroe, K. W., H. L. Weiss, M. Jones, and E. W. Hook III.** 2003. Acceptability of urine screening for *Neisseria gonorrhoeae* and *Chlamydia trachomatis* in adolescents at an urban emergency department. Sex. Transm. Dis. **30:**850–853.
17. **Morré, S. A., I. G. M. Van Valkengoed, R. M. Moes, A. J. P. Boeke, C. J. L. M. Meijer, and A. J. C. Van Den Brule.** 1999. Determination of *Chlamydia trachomatis* prevalence in an asymptomatic screening population: performances of the LCx and COBAS Amplicor tests with urine specimens. J. Clin. Microbiol. **37:**3092–3096.
18. **Podgore, J. K., K. K. Holmes, and E. R. Alexander.** 1982. Asymptomatic urethral infections due to *Chlamydia trachomatis* in male US military personnel. J. Infect. Dis. **146:**828–831.
19. **Quinn, T. C., L. Welsh, A. Lentz, K. Crotchfelt, J. Zenilman, J. Newhall, and C. Gaydos.** 1996. Diagnosis by AMPLICOR PCR of *Chlamydia trachomatis* infection in urine samples from women and men attending sexually transmitted disease clinics. J. Clin. Microbiol. **34:**1401–1406.
20. **Rietmeijer, C. A., K. J. Yamaguchi, C. G. Ortiz, S. A. Montstream, T. Leroux, J. M. Ehret, F. N. Judson, and J. M. Douglas.** 1997. 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. **24:**429–435.
21. **Stamm, W. E., L. A. Koutsky, J. K. Benedetti, J. L. Jourden, R. C. Brunham, and K. K. Holmes.** 1984. *Chlamydia trachomatis* urethral infections in men. Prevalence, risk factors, and clinical manifestations. Ann. Intern. Med. **100:** 47–51.
22. **Stary, A., A. Tomazic-Allen, B. Chouieri, J. Burczak, K. Steyrer, and H. Lee.** 1996. Comparison of DNA amplification methods for the detection of *Chlamydia trachomatis* in first-void urine from asymptomatic military recruits. Sex. Transm. Dis. **23:**97–102.
23. **Toye, B., R. W. Peeling, P. Jessamine, P. Claman, and I. Gemmill.** 1996. Diagnosis of *Chlamydia trachomatis* infections in asymptomatic men and women by PCR assay. J. Clin. Microbiol. **34:**1396–1400.
24. **Van Der Pol, B., T. C. Quinn, C. A. Gaydos, K. Crotchfelt, J. Schachter, J. Moncada, D. Jungkind, D. H. Martin, B. Turner, C. Peyton, and R. B. Jones.** 2000. Multicenter evaluation of the AMPLICOR and automated COBAS AMPLICOR CT/NG tests for detection of *Chlamydia trachomatis*. J. Clin. Microbiol. **38:**1105–1112.
25. **Van Der Pol, B., D. V. Ferrero, L. Buck-Barrington, E. Hook III, C. Lenderman, T. Quinn, C. A. Gaydos, J. Lovchik, J. Shachter, J. Moncada, G. Hall, M. J. Tuohy, and R. B. Jones.** 2001. Multicenter evaluation of the BDProbeTec ET system for detection of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in urine specimens, female endocervical swabs, and male urethral swabs. J. Clin. Microbiol. **39:**1008–1016.