Screening for Gonorrhea: Update of the Evidence

Nancy Glass, PhD, MPH, RN; Heidi D. Nelson, MD, MPH; Kim Villemyer, BA

This update of the evidence report examines evidence of the effectiveness of screening for gonorrhea in asymptomatic sexually active men and women including adolescents and pregnant women. It reviews studies of screening strategies, individual and population-level risk factors, characteristics and accuracy of tests used for screening, harms of chemoprophylaxis treatment for newborns, and cost effectiveness of universal and targeted screening strategies. This review is an update and includes only studies published since the last recommendations of the U.S. Preventive Services Task Force (USPSTF) were released in 1996.[1]

Contents

Figures

Tables

Evidence Tables

Appendixes

Structured Abstract

Context: Gonorrhea, caused by *Neisseria gonorrhoeae,* is second only to chlamydia in the number of sexually transmitted disease (STD) cases reported to the U.S. Centers for Disease Control and Prevention (CDC) annually. The prevalence of gonococcal infection varies depending on the population and setting, and the highest rates are reported among young males and females, African Americans, and men who have sex with men.

Objective: To examine the effectiveness of screening for gonorrhea in asymptomatic sexually active men and women including adolescents and pregnant women. This systematic review focuses on studies of screening strategies and their outcomes, individual and population-level risk factors, characteristics and accuracy of tests used for screening, adverse effects of chemoprophylaxis treatment for newborns, and cost effectiveness of universal and targeted screening strategies.

Data Sources: MEDLINE® database (January 1966-July 2004), reviews, Web sites, and experts.

Study Selection: English-language abstracts were dual-reviewed for eligibility and only studies published in 1996 or later were included. Papers were selected for full review if they addressed key questions in the target populations.

Data Extraction: Relevant data were extracted from each study and summarized in evidence tables. Predefined criteria from the USPSTF were used to assess the internal validity of included studies.

Results: No new evidence was identified that evaluated the effectiveness of population screening to reduce transmission and improve health outcomes. Individual-level risk factors include young age (<25 years), African American race, multiple sex partners or an infected sex partner, inconsistent use of barrier contraceptives, previous or coexistent STDs, douching, use of drugs, and history of incarceration. Contextual risk factors include sexual networks, sexual mixing within a community or neighborhood with high prevalence of STDs, and residence in a community with limited social capital or markers of physical deterioration. New testing technologies, such as nucleic acid amplification tests and nucleic acid hybridization tests, demonstrate high sensitivity and specificity, although studies are methodologically limited. Sensitivity is lower using urine specimens for some tests, and may vary by symptom status.

Conclusions: Recent evidence only addresses key questions about risk factors and new tests. These studies are limited by descriptive, cross-sectional designs focusing on highly prevalent communities and settings, such as inner city STD clinics, that may not generalize to primary care.

Chapter 1. Introduction

Burden of Condition and Epidemiology

Gonorrhea, caused by *Neisseria gonorrhoeae,* was second only to urogenital *Chlamydia trachomatis* infection in the number of sexually transmitted disease (STD) cases reported to the U.S. Centers for Disease Control and Prevention (CDC) in 2003.[2] The most recent data indicate that up to 335,104 new gonococcal infections occurred in 2003.[2] The overall prevalence of gonococcal infection in a national representative sample of over 14,000 young adults aged 18 to 26 years was 0.43% (95% confidence interval [CI], 0.29%-0.63%),[3] although prevalence varies from negligible to 41% depending on the population and setting.[3-15] Prevalence rates in the U.S. are currently highest among populations of African Americans and men who have sex with men (MSM).[2, 3]

There are several similarities between gonococcal and chlamydial infections. The age distribution of individuals with gonorrhea is similar to that for chlamydia with the highest rates reported among female adolescents 15 to 19 years old, and adult males and females 20 to 24 years old.[3, 16, 17] Expert reviewers for this report noted that the peak age for gonorrhea is about five years older than for chlamydial inventions.

In women and men, uncomplicated gonorrhea is usually confined to the mucosa of the cervix, urethra, rectum, and throat and is often asymptomatic.[2] Pharyngeal and rectal infections are typically asymptomatic. In women, gonorrhea is a major cause of cervicitis, and its complications include pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and chronic pelvic pain.[16] Among young women, infections often do not produce recognizable symptoms until complications such as PID have occurred. Infections are also related to adverse pregnancy outcomes such as chorioamnionitis, premature rupture of membranes, and preterm labor.[16] Perinatal transmission to infants can cause severe conjunctivitis resulting in blindness if untreated, and, rarely, sepsis with associated meningitis, endocarditis, or arthritis.[16]

In men, gonorrhea can result in symptomatic urethritis, epididymitis, and prostatitis.[16] Most reports indicate that the majority of genital infections among men are symptomatic and lead to treatment early enough to prevent serious complications, but not transmission to others.[2] However, one study reported that only 40% of men who screened positive for gonococcal infection were symptomatic and another study concluded that less than 5% of men with urethral gonorrhea reported dysuria and none reported penile discharge during the 24 hours prior to screening.[3,18]

Rarely, local gonococcal infection disseminates to cause an acute dermatitis tenosynovitis syndrome, which can be complicated by arthritis, meningitis, or endocarditis.[16] Gonococcal infection may increase susceptibility to and transmission of human immunodeficiency virus (HIV) in both men and women.[19]

Health Care Interventions

Several tests for infection with *N. gonorrhoeae* are currently available (Table 1).[2, 17, 20] Culture analysis using swab specimens was traditionally considered the diagnostic gold standard. The advantages of culture include low cost, use with different specimen types (endocervix, urethra, pharynx, or rectum), and the ability to retain the isolate for additional testing, such as for antibiotic resistance. Culture technology poses methodological shortcomings, however, including variation in sensitivity and specificity, need for careful handling to maintain viable organisms, a wait of 2 to 3 days for presumptive results, and the need for invasive sampling.[17, 21]

Non-culture tests using swab specimens were developed to improve upon some of the limitations of culture. These tests initially included antigen detection tests such as enzyme immunoassay (EIA). The performance and cost associated with EIA have not made them competitive with culture analysis for detecting *N. gonorrhoeae.*[17] Newer technologies are based on amplified DNA or RNA assays (nucleic acid amplification tests [NAATs]). The amplification methods and the target nucleic acid sequences differ by manufacturer and include polymerase chain reaction (PCR), strand displacement amplification (SDA), and transcription-mediated amplification (TMA). Non-culture tests offer advantages of improved sensitivity, wider availability, less stringent handling requirements that are not dependent upon living organisms, and timely results.[17] NAATs can be used with either urine or swab specimens for men and women providing a more acceptable method of noninvasive specimen collection, and allowing for screening in non-traditional settings (e.g. school-based clinics, job training programs, substance abuse treatment programs). These tests can detect *C. trachomatis* or *N. gonorrhoeae* in a single specimen. A disadvantage of some NAATs, specifically PCR platforms, is that specimens can contain amplification inhibitors that result in false negative results. NAATs require a high level of technical laboratory expertise to perform the test. Also, non-culture techniques cannot be used for antibiotic resistance testing. The sensitivity of NAATs can vary by specimen type with particularly low sensitivity for PCR using urine samples from women.[17] Some experts recommend confirming non culture test results because of potential false positive results, particularly among asymptomatic individuals.[22-24]

Nucleic acid hybridization (nucleic acid probe) tests are also available commercially, and both of the U.S. Food and Drug Administration (FDA) approved tests, PACE® 2 and the Hybrid Capture II®, can detect *C. trachomatis* or *N. gonorrhoeae* in a single specimen.[17] The advantage of the nucleic acid hybridization test is the ability to store and transport specimens for up to seven days without refrigeration before testing by the laboratory. These tests also require a high level of technical laboratory expertise to perform the test, and have lower sensitivity than NAATs.[17]

All currently available tests require sending the specimen to a laboratory. There are few options for point of care testing for *N. gonorrhoeae.* Gram stain is most reliable for the presumptive identification in urethral exudates for men, but is not recommended for women

because of low sensitivity and variable specificity.[17] However, its application to screening is limited because it requires use of intraurethral swab specimens if no discharge is present.[17]

Although there are a variety of screening tests, the performance of routine STD screening in medical practice is low. A random sample of 7,300 physicians in five specialties (obstetrics/gynecology, internal medicine, general practice or family medicine, emergency medicine, and pediatrics) indicated that fewer than one-third routinely screened for STDs.[25] Surveyed physicians reported screening 13% of men, 30% of non-pregnant women, and 31% of pregnant women for gonorrhea in their practices.[25]

Most screening programs target young women in STD or family planning clinics because of the relatively high prevalence rates among patients in these settings, and to take advantage of the opportunity to obtain diagnostic tests in the context of other services.[26] Young men have been much more difficult to screen and study. Screening programs have been implemented in emergency departments, school-based clinics, juvenile detention centers and jails, and job training programs.[18, 27-38] Community-based gonorrhea screening using self-collected mailed specimens has been studied for feasibility and acceptability.[39, 40]

The most recent treatment recommendations by the CDC were published in 2002.[41] Approved treatments for uncomplicated gonococcal infections of the cervix, urethra, and rectum include one of the following antibiotic regimens: cefixime 400 mg orally in a single dose; ceftriaxone 125 mg IM in a single dose; ciprofloxacin 500 mg orally in a single dose; ofloxacin 400 mg orally in a single dose; levofloxacin 250 mg orally in a single dose. Also, if co-existing genital chlamydia infection is not ruled out, the CDC recommends presumptive treatment with azithromycin 1 g orally in a single dose or doxycycline 100 mg orally twice daily for 7 days. Gonococcal infections of the pharynx are more difficult to eradicate than infections at urogenital and anorectal sites. Few antimicrobial regimens can reliably cure >90% of infections. The CDC recommended antibiotics for pharyngeal gonococcal infections include ceftriaxone 125 mg IM in a single dose or ciprofloxacin 500 mg orally in a single dose. Also, if co-existing genital chlamydia infection is not ruled out, the CDC recommends presumptive treatment with azithromycin 1 g orally in a single dose or doxycycline 100 mg orally twice daily for 7 days. To prevent gonococcal ophthalmia neonatorum, a prophylactic agent should be instilled into the eyes of all newborn infants. This procedure is required by law in most states. All of the recommended prophylactic regimens prevent gonococcal ophthalmia and include a single application of silver nitrate (1%) aqueous solution, erythromycin (0.5%) ophthalmic ointment, or tetracycline ophthalmic ointment (1%).[41]

Experts caution that fluoroquinones are not recommended in young adolescents, and fluoroquinone resistant strains of gonorrhea are emerging. The CDC recommends that fluoroquinones not be used in MSM and in patients who acquired their infections in California, Hawaii, Asia, or other areas with increased resistance to fluoroquinones.[42, 43]

Prior Recommendations of the USPSTF

In 1996, the U.S. Preventive Services Task Force (USPSTF) recommended that clinicians should routinely screen for gonorrhea in asymptomatic women at high risk for infection (e.g. commercial sex workers, those with a history of repeated episodes of gonorrhea, and young women under the age 25 with two or more sexual partners in the past year) ("B" recommendation).[1]

There was insufficient evidence to recommend for or against screening high-risk men (e.g. young, sexually active) for gonorrhea, and routine screening of men or women was not recommended in the general population of low-risk adults ("D" recommendation).

For pregnant women, the USPSTF recommended screening at the first prenatal visit for those who fall into one of the high-risk categories and an additional test in the third trimester for those at continued risk for acquiring gonorrhea ("B" recommendation). There was insufficient evidence to recommend for or against universal screening of pregnant women ("C" recommendation).

In the case of chemoprophylaxis against transmission in newborns, the USPSTF recommended that erythromycin 0.5% ophthalmic ointment, tetracycline 1% ophthalmic ointment, or 1% silver nitrate solution should be applied topically to the eyes of all newborns as soon as possible after birth and no later than 1 hour after birth ("A" recommendation).

Analytic Frameworks and Key Questions

The analytic frameworks in Figures 1-3 indicate the strategy used to guide the literature search for evidence of the effectiveness of screening for gonorrhea in asymptomatic sexually active men and women including adolescents and pregnant women. The accompanying key questions correspond to selected numbered arrows in the three analytic frameworks. Key questions were identified by the USPSTF as areas with unresolved issues relevant to clinical practice with potentially new studies since the last USPSTF recommendations were published in 1996. These include:

Key Questions: Asymptomatic Men and women including adolescents

1A. Does screening women reduce complications and transmission of disease?
1B. Does screening men reduce complications and transmission of disease?
2A. What individual-level risk factors identify groups at higher risk for gonococcal infection?
2B. What population-level characteristics identify groups at higher risk for gonococcal infection?

2C. What individual-level risk factors identify groups at higher risk for gonococcal infection when used in conjunction with population-level or provider-level characteristics?
2D. What are the screening tests and their performance characteristics?
2E. What is the yield of screening in different risk populations?
2F. Does performance of screening tests vary by specimen type?
2G. What is the role of screening for gonococcal infection among men who have sex with men (MSM)?
3A. What is the evidence on cost effectiveness for universal vs. targeted strategies?
3B. Are dual chlamydia-gonorrhea screening tests cost-effective?

Key Questions: Pregnant women

1A. Does screening reduce adverse maternal/pregnancy outcomes (septic abortion, stillbirth, preterm delivery/low birth weight)?
1B. Does screening reduce adverse neonatal outcomes (gonococcal conjunctivitis, blindness)?
2A. Does screening reduce maternal complications (chorioamnionitis, premature rupture of membranes, preterm labor)?
2B. Does screening reduce transmission to the newborn?
3. What is the evidence on cost effectiveness for universal vs. targeted strategies?

Key Questions: Newborn chemoprophylaxis

1. What are the adverse effects of treatment?

Chapter 2. Methods

Literature Search Strategy

The topic of gonorrhea was searched in the MEDLINE® database (January 1966 through July 2004) by a research librarian. A total of nine searches were performed on prevalence, screening programs, risk factors, screening tests and test performance, and cost. Searches specifically related to pregnancy included maternal and neonatal complications and outcomes. A specific search on neonatal chemoprophylaxis was also performed. Detailed electronic search strategies are presented in Appendix 1. Periodic hand searching of relevant medical journals and reference lists, and suggestions from experts supplemented the electronic searches. Relevant systematic reviews, policy statements, and other papers with contextual value were also obtained.

Inclusion and Exclusion Criteria

English-language abstracts were dual-reviewed for eligibility. Only studies published in 1996 or later were included in this update. Papers were selected for full review if the abstracts were about screening strategies in the target populations; individual and population-level risk factors; characteristics and accuracy of tests used for screening; adverse effects of chemoprophylaxis treatment for newborns; as well as evidence on cost effectiveness for universal and targeted screening strategies. Studies were included if they were conducted in the U.S., Australia, Canada, and Western Europe because of similar epidemiology and management of gonorrhea in these countries. Studies of non-human subjects and those without original data were excluded. Foreign language papers were considered if they were randomized controlled trials related to a key question and the abstract was in English.

Studies of screening strategies and programs were included if they met additional criteria. Screening is defined as testing in asymptomatic persons, and "case finding" in those found to have another sexually transmitted infection. Universal screening means testing everyone regardless of symptoms or risk factors; targeted screening indicates that only those who meet specific criteria are tested. Studies about screening programs were included if they described the study population (number screened, sex, age range, setting, presence of symptoms, and other available socio-demographic factors), features of the screening program (duration, type of testing, follow-up), and outcome measures.

Studies of risk factors for gonococcal infection were included if they reported the number screened, sex, age, setting, reason for visit, screening criteria (universal vs. targeted), type of gonococcal test, other forms of data collection (e.g. questionnaire), and prevalence rates of the tested populations. Results included odds ratios for gonococcal infection from univariate or multivariate regression analysis and significance levels for comparisons between infected and non-infected women and/or men. Risk factors that were not significantly related to gonococcal infection were noted when reported.

This review focused on the new nucleic acid amplification tests obtained by both swab and urine specimens published since 1996. Studies of test performance were included in the summary table only if they met quality criteria at the fair or good-quality level including: 1) the test was appropriately performed in a standardized manner; 2) the gold standard was appropriately used; 3) the study population was adequately described; and 4) data were sufficient to determine the sensitivity and specificity of tests. Outcome measures included sensitivity, specificity, positive predictive value, and negative predictive value of tests evaluated.

Data Extraction and Synthesis

Relevant data were extracted from each study and summarized in evidence tables. In general, these include descriptions of the study population and setting, characteristics of the screening program or test, and outcomes. Studies of risk factors reported associations between infections and risk factors. Predefined criteria from the USPSTF were used to assess the internal validity of included systematic reviews, randomized controlled trials, and observational studies (Appendix 2).[44] Studies were also considered for applicability to the population that would be identified by screening.

Size of Literature Reviewed

Investigators reviewed 1576 abstracts identified by the searches (Appendix 3). From the searches, 310 full-text articles were reviewed. An additional 12 non-duplicate articles identified from reference lists and experts were also reviewed. The draft report was reviewed by task force members, and content and methodology experts (Appendix 4).

Chapter 3. Results

Asymptomatic Men and Women Including Adolescents

Key Question 1A. Does screening women reduce complications and transmission of disease?

No studies meeting inclusion criteria addressed this question.

Key Question 1B. Does screening men reduce complications and transmission of disease?

No studies meeting inclusion criteria addressed this question.

Key Question 2A. What individual-level risk factors identify groups at higher risk for gonococcal infection?

Fifteen studies published since 1996 describe individual-level risk factors for gonococcal infection among men tested in the military, and heterosexual women and men tested in community, primary care, family planning, and STD clinics (Evidence Table 1).[5, 11, 14, 15, 18, 28-31, 35-37, 45-47] Studies specifically about men who have sex with men are presented under Key Question 2G. Studies of risk factors are descriptive and focus on urban high prevalence populations in community and clinical settings. Studies do not specifically define risk assessment criteria appropriate for screening most heterosexual men and women presenting to primary care settings. No studies prospectively test risk criteria in an asymptomatic screening population to determine its accuracy. The feasibility of using behavioral risk factors for screening is compromised by the difficulty of obtaining this information and its questionable reliability compared with demographic data.

Table 2 summarizes significant findings from the included studies. Ten of 11 studies, representing a wide range of settings and prevalence rates (0.1% to 100%), reported young age as an important predictor.[5, 14, 29-31, 35-37, 47] Age was usually expressed as under 21 or under 25 years old. Five of 6 studies for which race was an analyzed factor reported African American and other non-white race as significantly associated with gonorrhea.[5, 14, 30, 36, 46]

Frequently cited behavioral risk factors have included multiple partners,[5, 11, 14, 27, 30, 31, 48] partner with symptoms of STD,[31] inconsistent or no use of barrier contraception,[14, 28, 31] drug use,[5, 14, 28, 36] and incarceration.[14] Personal history of PID,[5, 27] STD,[5, 18, 30, 45, 46] douching,[31] and oral contraceptive use[29] were also noted as risk factors in some studies. The variation in methods, definitions, and individual-level risk factors assessed across studies do not allow further synthesis of the results. Physical findings on examination such as discharge and co-existent chlamydial infection were also predictive of gonorrhea infection.[5, 18, 30, 45, 46] These

factors, however, would necessitate gonorrhea testing for reasons other than screening and would not be helpful in forming a targeted screening strategy.

Specific studies of individual risk factors. A cross-sectional survey examined characteristics of urethral gonococcal infection in male army recruits (n=2,245).[18] The mean age of subjects was 20.6 years (range 17-35 years), 89% of participants were under 25 years old, and 60% were white. A majority (87%) reported ever having vaginal sex, 33% reported having sex with more than one partner in past 90 days, and 34% reported having sex with a new partner in past 90 days. Twenty percent reported using condoms every time they had sex, and 2.4% reported a previous diagnosis of gonorrhea. The overall prevalence of gonorrhea was 0.6%, and 7.5% of participants with gonococcal infection were co-infected with chlamydia. Of those testing positive for gonorrhea, 40% reported having symptoms of any kind. Of these, 60% were co-infected with chlamydia. Young age (<25 years) was not a significant predictor of gonorrhea, however, this finding may be the result of the limited age range of the male participants.

A case-control study examined risk factors for male acquisition of gonorrhea in 214 men age 15 to 29 years old seen in STD clinics in Newark, New Jersey.[14] Men with culture confirmed gonorrhea (cases) were compared with controls that had no STDs. A previous diagnosis of gonorrhea was reported by 41% of cases and 29% of controls, and a history of another STD was reported by 17% of cases and 25% of controls. Cases were more likely than controls to be African American (odds ratio [OR]=4.2; 95% CI, 1.5-11.5), younger (OR=2.6; 95% CI, 1.2-5.4), or to ever have spent a night in jail (OR=2.3; 95% CI, 1.4-3.9). There were no differences in the percentages of those who finished 12 years of school or were employed. Compared with controls, cases reported a least one casual sex partner within the preceding month (OR=3.2; 95% CI, 1.8-5.7), sex after using marijuana during the preceding month (OR=2.4; 95% CI, 1.1-11.2), a history of incarceration (OR=2.1; 95% CI, 1.2-3.7), and age 15 to 19 years (OR=2.1; 95% CI, 1.0-4.2). Inconsistent condom use was highly prevalent for both case (63%) and control (50%) groups.

A prospective study of adolescent and adult women (n=477) identified behaviors associated with gonorrhea and chlamydia infections following a behavioral risk reduction intervention for Mexican American and African American women.[31] The majority (70%) of the urban sample was under 25 years of age (age range 14-45 years), and all had low income and limited education. The intervention, Project SAFE (Sexual Awareness for Everyone), focused on five modifiable sexual risk behaviors (e.g. sex with untreated partner, not mutually monogamous, unsafe sex, rapid partner turnover, douches after sex). Infection rates were 18% for the intervention group vs. 26% for the control group at the end of the 12-month study, and the regression model demonstrated that behaviors correctly predicted infection rates in 75% of participants. Unprotected sex with an untreated/incompletely treated partner had the strongest association with infection (cumulative adjusted OR=5.6; 95% CI, 3.0-10.5). Unsafe sex (e.g. no or inconsistent condom use) (OR=1.9; 95% CI, 1.1-3.3), and rapid partner turnover were significantly associated with gonococcal infection (OR=2.7; 95% CI, 1.6-4.8).

Two prospective studies and a case-control study were conducted in urban clinic settings to examine the risk for recurrent gonococcal infection in sexually active females and males.[45, 46, 49] A current diagnosis or recent history of another STD were significant predictors in all three studies, and unsafe sex behaviors had little impact on subsequent risk for gonococcal infection in two of the studies.[45, 46]

Key Question 2B. What population-level characteristics identify groups at higher risk for gonococcal infection?

Four studies of population-level characteristics and their associations with gonococcal infection met inclusion criteria (Evidence Table 2).[50-53]

In a study using data from all U.S. states, associations between social capital, poverty, income inequality, and four infectious diseases, including gonorrhea, were examined.[51] Predictor variables included:

1) Social capital, defined by Putnam's public use dataset including 14 variables that span the domains of community organizational life, involvement in public affairs, volunteerism, informal sociability and social trust.
2) Poverty, defined by the percentage of the state population living below the poverty line.
3) Income inequality, measured as the ratio of mean income for the top earning one-fifth of families to the bottom one-fifth.

The outcome variables were defined by the 1999 federal surveillance of STDs. Low social capital was significantly correlated to all STDs studied, including gonorrhea ($p<0.01$).[51] High poverty was significantly correlated with chlamydia, and income inequality was significantly correlated with chlamydia and AIDS case rates but not gonorrhea.

A retrospective geographic/regional analysis in San Francisco included patients 14 to 35 years old with initial infections with gonorrhea (n=12,506) and chlamydia (n=9,461), and investigated whether core groups of transmitters existed.[50] Over 5 years, 8,613 cases of recurrent gonorrhea occurred among males (17%) and 3,893 among females (19%). Recurrences were more likely in geographically defined populations, independent of race and ethnicity, suggesting core groups of transmitters. These cores have been furthered studied using a geographic information system (GIS) linked to disease surveillance, providing additional information on the geographic epidemiology of gonorrhea and other STDs.[53]

In a cross-sectional study in New Orleans, LA, researchers performed a regression analysis indicating that traditional variables associated with gonorrhea risk such as poverty, race and unemployment are not as predictive of gonorrhea rates as markers of neighborhood deterioration (e.g. broken windows) ($p=0.005$).[52]

Key Question 2C. What individual-level risk factors identify groups at higher risk for gonococcal infection when used in conjunction with population-level or provider-level characteristics?

No studies meeting inclusion criteria addressed this question.

Key Question 2D. What are the screening tests and their performance characteristics?

A total of 25 studies published since 1996 addressing one or more of the key questions about screening tests and their performance characteristics were identified by the literature search (Evidence Table 3).[54-78]

Of these, three were rated good quality,[56, 76, 78] 13 fair,[55, 57, 60, 61, 63-65, 67, 68, 70, 72, 75, 77] and nine poor.[54, 58, 59, 62, 66, 69, 71, 73, 74] Most studies rated poor quality were limited by inappropriate use, or lack, of a confirmatory or discrepant test.

Most studies were conducted in populations that differed from the target population for this review, specifically prisoners, patients in STD and family planning clinics, contacts of known cases, and other high-risk individuals. Most studies included both symptomatic and asymptomatic individuals and few studies reported results by symptom status. No study specifically focused on adolescents, and the one study that included women age 15 to 44 years did not report results by age.[69] Sensitivity and specificity of tests are likely to be lower than reported in studies when generalized to clinical practice because of less rigorous specimen collection, increased transport time with deterioration of samples, and variability in the quality of the laboratories performing the tests. Most studies had too few positive samples to be considered statistically valid, and none of the performance parameters were provided with confidence intervals to express the level of uncertainty with the estimates. Confirmatory or discrepant testing was inconsistent across studies. Considering these limitations, studies are too heterogeneous for statistical meta-analysis and are presented descriptively in this report.

Five fair or good quality studies reported sensitivity and specificity of cervical or urethral culture specimens.[57, 65, 70, 75, 77] Specificity was considered 100% because most studies defined culture as the gold standard, and sensitivity varied from 65.2% to 92.6%.[57, 65, 70, 75, 77] Results for cervical, urethral, and urine specimens using NAATs included: PCR sensitivity 42.3% to 100%, specificity 95.9% to 100%, five studies.[57, 60, 70, 72, 76] SDA sensitivity 83.7% to 100%, specificity 94.7% to 100%, three studies[56, 65, 72] and TMA sensitivity, 87.5% to 100%, specificity 98.1% to 99.6%, two studies.[77, 78] Two studies of nucleic acid hybridization tests (nucleic acid probe) reported sensitivities ranging from 92.2% to 92.6%, and specificities from 98.5% to 99.8%.[64, 75]

Key Questions 2E and 2F. What is the yield of screening in different risk populations? Does performance of screening tests vary by specimen type?

Studies of tests examined new technologies in women, men, and combined groups using endocervical, vaginal, urethral, urine, rectal, and pharyngeal specimens. Further analysis based on age or risk was not provided. Results of studies rated good or fair quality are shown in Figures 4 to 9 and described below.

Studies in women using endocervical and vaginal specimens. Ten studies reported test results for women using endocervical and vaginal specimens;[56-58, 60, 64, 65, 70, 76-78] some included more than one type of test. Five reported culture results,[57, 58, 65, 70, 77] four PCR,[57, 60, 70, 76] two SDA,[56, 65] two TMA,[77, 78] and two DNA probe[58, 64] (Figure 4). Most studies reported sensitivity of 90% or above, and specificity of 97% or above. Outliers included sensitivity below 90% in four of five studies using culture.[58, 65, 70, 77]

Studies in women using urine specimens. Six studies evaluated tests for women using urine specimens, some included more than one type of test, including four studies of PCR,[60, 70, 72, 76] two of SDA,[56, 72] and one of TMA[78] (Figure 5). Sensitivity was below 90% in the one study of TMA,[78] two of four studies of PCR,[60, 76] and one study of SDA;[56] specificity was below 97% in one study of PCR.[70] In five studies evaluating both cervical and urine specimens, sensitivity was lower for urine specimens when using PCR,[60, 70, 76] TMA,[78] and SDA,[56] while specificity was generally comparable between specimen types.

Studies in men using urethral specimens. Four studies evaluated test technologies using urethral specimens in men, some included more than one type of test (Figure 6).[56, 60, 70, 76] Culture was evaluated in one study,[70] PCR in three,[60, 70, 76] and SDA in one.[56] Sensitivity was below 90% in studies of PCR[76] and culture;[70] specificity was below 97% in one study of SDA.[56]

Studies in men using urine specimens. Five studies evaluated tests for men using urine specimens, some included more than one type of test, including four studies of PCR[60, 70, 72, 76] and two of SDA[56, 72] (Figure 7). Sensitivity was below 90% in one study of SDA[56] and one study of PCR;[76] specificity was below 97% in one study of SDA.[56] In four studies evaluating both urethral and urine specimens in men, sensitivity was slightly lower for urine specimens when using PCR[60, 70, 76] and similar with SDA,[56] while specificity was generally comparable between specimen types.

Studies in men who have sex with men using pharyngeal and rectal specimens. A study of testing in a sample of 161 men who have sex with men (MSM) used the PACE® 2 assay (nucleic acid hybridization test) and culture to test pharyngeal and rectal swab specimens.[67] For PACE® 2, sensitivity was 94.1% and specificity 100% with rectal specimens, and sensitivity was 86.4% and specificity 100% with pharyngeal specimens (Figures 8 & 9). For culture, sensitivity was 88.2% for rectal specimens and 59% for pharyngeal specimens.

Studies comparing test results of symptomatic vs. asymptomatic individuals. A study of TMA in women indicated lower sensitivity among asymptomatic vs. symptomatic women (96.9% vs. 100% for cervical specimens, 87.5% vs. 92.6% for urine), but no differences in specificity.[78] For SDA, sensitivity was slightly higher in asymptomatic vs. symptomatic women (97.4% vs. 96.1% for cervical specimens, 86.5% vs. 83.7% for urine), with no differences in specificity.[56]

In men, the sensitivity of PCR for both urethral and urine specimens was lower among asymptomatic vs. symptomatic men (73.1% vs. 98.1% for urethral specimens, 42.3% vs. 94.1% for urine), with no differences in specificity.[76] Results for SDA indicated slightly higher sensitivity and specificity for asymptomatic vs. symptomatic men (100% sensitivity and 99.5% specificity vs. 98.4% and 94.8% for urethral specimens, 100% sensitivity and 100% specificity vs. 97.9% and 94.4% for urine).[56]

Studies of new sampling techniques. Three studies evaluated the feasibility and acceptability of self-collected specimens for gonorrhea testing.[13, 39, 40] The use of self-collected vaginal swabs for gonorrhea and chlamydia testing was examined in adolescent females seen for non-gynecological symptoms in a school-based clinic.[13] The median age of subjects was 16 years, 46% were African American and 47% were white. Two percent of the participants tested positive for gonorrhea. Use of self-collected vaginal swabs was reported as easy to perform (99%) and preferable to a gynecological examination (84%). Nearly all (97%) stated that they would undergo testing at frequent intervals if self-testing was available.

The feasibility and acceptability of urine-based gonorrhea retesting using mailed specimens was evaluated in heterosexual patients 14 years or older who had recent positive tests for gonorrhea and/or chlamydia.[40] One hundred and twenty-two patients were randomized to two groups: 1) clinic retesting only, or 2) option for clinic retesting or mailing urine specimens to the clinic. Of those randomized to mail/clinic option, 70% chose clinic retesting and 30% chose mail retesting. Age, race, gender and STD diagnosis did not differ between groups. The majority of those who chose to retest by mail were successfully retested within one month of initial diagnosis.

A descriptive study of home-based testing used free urine test kits available from local businesses that were then mailed by the user to the health department.[39] The study was conducted among a population of predominantly MSM with higher than average rates of STDs (Castro neighborhood of San Francisco, CA). A total of 209 kits were picked up, and 80 (38%) were returned to the health department. Results indicated one chlamydia infection and 3 gonorrhea infections. Respondents' biggest concern about this type of testing was confidentiality.

Key Question 2G. What is the role of screening for gonococcal infection among men who have sex with men (MSM)?

No studies meeting inclusion criteria addressed this question.

Studies relevant to gonorrhea infection in men who have sex with men. Two studies examined trends in rates of gonorrhea infection, decline in safe sex practices, and associations with the availability of highly active antiretroviral therapy (HAART).[79, 80] A retrospective analysis of MSM seeking care in clinics (n=8,000) examined rates of gonorrhea from 1982 to 2001, and compared rates during pre-HAART (1990 to 1995) and post-HAART (1996 to 2001) periods.[80] Although gonorrhea rates for all individuals declined between 1982 and 1998 and stabilized at low rates, rates for MSM increased after 1995. Rates for MSM were significantly higher during the post-HAART (12.9%) than pre-HAART periods (8.1% $p<0.0001$). In MSM known to be HIV positive, gonorrhea rates increased from 11.6% in the pre-HAART to 24% in the post-HAART period ($p<0.00001$).

A retrospective analysis of behavioral factors and changes in incidence of male rectal gonorrhea was conduced in 21,587 MSM.[81] Rectal gonorrhea declined from 1990 to 1993, and increased from 1994 to 1997 from 21 to 38 per 100,000 adult men ($p<0.01$). This increase was observed in all racial/ethnic and age groups but was highest among men aged 25 to 34 years.

Three studies examined individual-level risk factors for gonococcal infection in MSM.[82-84] A cross-sectional survey identified behavioral risk factors associated with rectal gonorrhea in MSM (n=564) by HIV serostatus.[84] The median age of participants was 33 years (range 18 to 74), 65% were white, and 78% reported some college education. MSM were included in the study if they reported receptive anal sex in the past six months. Twenty percent of the sample was HIV positive, 21% reported unknown HIV status, 90% reported no rectal symptoms, and 7% had rectal gonorrhea. HIV positive men were significantly more likely to have rectal gonorrhea than men with unknown or negative HIV status (OR=3.5, 95% CI, 1.9-5.8). HIV positive men who engaged in anonymous sex were at highest risk for rectal gonococcal infection. Men with unknown or negative HIV status were at highest risk if using drugs during anal sex.

A medical record review of MSM (n=1,253) seen in an urban STD clinic assessed behavioral and demographic determinants of STD acquisition.[83] Oral insertive intercourse was independently associated with urethral gonorrhea (OR 4.4, 95% CI, 1.4-13.4). A cross-sectional study examined the prevalence of urethral infections in MSM (n=566) and found no cases of gonorrhea and few cases of chlamydia, even among those with multiple sexual partners.[82]

Key Question 3A. What is the evidence on cost effectiveness for universal vs. targeted strategies?

A decision analysis compared standard emergency department (ED) screening practice to four enhanced screening strategies in a theoretical cohort of 10,000 female and male patients aged 18 to 31 years.[85] The five screening strategies included: 1) standard practice in which emergency clinicians rely on history and physical examination to decide whether to screen and treat; 2) universal screening; 3) selective screening for patients with risk factors combined with

standard ED practice; 4) screening all patients aged 18 to 31 years combined with standard ED practice; 5) mass treatment of all patients aged 18 to 31 years with antibiotics (e.g. single dose of 1 gm azithromycin and 500 mg ciprofloxacin). The outcomes were untreated gonorrhea or chlamydia cases and their sequellae, transmission to a partner, congenital outcomes, and cost to prevent a case of gonorrhea or chlamydia.

For women, each enhanced screening strategy was associated with less costs for clinical sequellae because of greater numbers of detected and treated infections than standard practice. Including programmatic costs and overhead, mass treatment of all women aged 18 to 31 years was the most cost-saving strategy and involved treatment of the most cases. Even with the side effects of medication accounted for, treating all women aged 18 to 31 years saved $436.54 per case treated compared with standard practice, and resulted in treatment of 1,005 additional cases of gonorrhea and chlamydia. In this modeling exercise, screening all women aged 18 to 31 years for both chlamydia and gonorrhea was found to be more cost effective than selective screening when the combined prevalence of gonorrhea and chlamydia was 7% to 17.5%.

For men, standard ED practice for detection and treatment of gonorrhea and chlamydia was more cost-saving than enhanced screening. This is most likely related to the lower costs of treatment and management of infections in men missed by screening, and the higher rates of symptomatic infections.

Although mass treatment without testing for gonorrhea and chlamydia was found to cost less for women in this analysis, the generalizability of this finding is limited because the study focused on an urban ED serving a high prevalence population. In considering the study's relevance to gonorrhea screening, it should be remembered that the reported savings are likely to have been driven by chlamydia with its higher prevalence rates. While this study did not consider the potential costs of antibiotic resistance associated with mass treatment, it also did not consider the acceptability of mass treatment to both patients and health care providers.

Key Question 3B. Are dual chlamydia-gonorrhea screening tests cost-effective?

No studies meeting inclusion criteria addressed this question.

Studies relevant to testing and treatment of dual infections. Patients infected with gonorrhea are frequently co-infected with chlamydia and routine dual treatment of patients with gonococcal infection is recommended and frequently practiced. A decision analysis examined the cost-effectiveness of routine dual treatment of women with gonococcal infection, with or without separate testing for chlamydia.[86] Three options were compared: 1) co-treat: test for gonorrhea, do not test for chlamydia, presumptively treat women with positive gonorrhea tests for both infections (baseline); 2) test: test for both infections, treat women with positive tests for their specific infections; 3) test/co-treat: test for both infections, treat women who test positive for any infection for both infections. Three tests for gonorrhea and chlamydia were considered including culture, nucleic acid amplification assay (ligase chain reaction [LCR]), and the combination nucleic acid hybridization test (PACE® 2). Program costs and new costs of the testing and

treatment algorithms were calculated. The outcome for each model was the number of cases of PID prevented. Regardless of the screening tests considered, including the combination test, the test/co-treat algorithm averted the greatest number of cases of PID, followed by the test algorithm. The co-treat algorithm averted the fewest cases of PID.[87]

The decision analysis indicates that determination of the optimal algorithm should be based upon the prevalence rate of chlamydial infection, not the co-infection rate. The prevalence of gonorrhea will be lower than the prevalence of chlamydia in most settings. A relatively high prevalence of gonorrhea infection is found among STD clinic and hospital emergency department patients, jail and prison inmates, and other populations. However, in other settings such as family planning and prenatal clinics, the prevalence of gonorrhea is typically low and lower than the prevalence of chlamydia, although the co-infection rate is often in the range of 20% to 40% suggested in the 1998 CDC guidelines. Even if the co-infection rate is high, the majority of women infected with chlamydia will not be treated if treatment is determined by the outcome of a gonorrhea test as outlined in the co-treat algorithm.

Pregnant Women

Key Question 1A. Does screening reduce adverse maternal/pregnancy outcomes (septic abortion, stillbirth, preterm delivery/low birth weight)?

No studies meeting inclusion criteria addressed this question.

Studies relevant to third trimester screening. Several professional groups, including the American College of Obstetricians and Gynecologists (ACOG) and the CDC, recommend repeat screening for gonorrhea during the third trimester for at-risk patients.[16, 88] Two studies provide new information on third trimester screening since the last USPSTF recommendation. A retrospective chart review of clinic records over a 29-month period was conducted to determine the value of late pregnancy (34 weeks' gestation) testing for gonorrhea after a negative initial test at the beginning of prenatal care.[89] Of 751 participants, 38 women (5.1%) had positive gonorrhea tests at the first screening, and 19 (2.5%) women had positive tests only at the second screening. A prospective study evaluated screening for gonorrhea using risk factors and routine third-trimester testing in a clinic setting. [90] Five hundred and forty-two women entering prenatal care participated in the study. The risk factors examined included age less than 20 years, marital status, history of STD or hepatitis, drug use, and gestational age at entry into prenatal care. In this study, 4% of the third-trimester tests for gonorrhea and chlamydia were positive after an initial negative test. The presence of risk factors, such as a history of STD, drug use, and age less than 20 years, increased the risk for a positive third-trimester test 7-fold in the study sample.

Key Question 1B. Does screening reduce adverse neonatal outcomes (gonococcal conjunctivitis, blindness)?

No studies meeting inclusion criteria addressed this question.

Key Question 2A. Does screening reduce maternal complications (chorioamnionitis, premature rupture of membranes, preterm labor)?

No studies meeting inclusion criteria addressed this question.

Key Question 2B. Does screening reduce transmission to the newborn?

No studies meeting inclusion criteria addressed this question.

Key Question 3. What is the evidence on cost effectiveness for universal vs. targeted strategies?

No studies meeting inclusion criteria addressed this question.

Newborn Chemoprophylaxis

Key Question 1. What are the adverse effects of treatment?

No studies meeting inclusion criteria addressed this question.

Chapter 4. Discussion

Summary of Evidence

A summary of the evidence relating to each key question is presented in Table 3. Gonorrhea is the second most common sexually transmitted bacterial pathogen in the U.S. and is capable of causing serious infections, such as PID, as well as long-term complications. Adolescents and young adults, African Americans, and men who have sex with men have the highest prevalence rates. Gonorrhea is readily transmitted between sexual partners and to newborns. Many individuals with gonorrhea, including the majority of infected women, do not have symptoms prompting them to seek medical treatment. Many infections, therefore, are undetected in the absence of screening.

The update of the evidence found no new evidence of the effectiveness of population screening in asymptomatic men and women, adolescents, pregnant women, and MSM to reduce transmission and improve health outcomes. Evidence is also lacking to answer important and clinically relevant issues about the added value of including gonorrhea testing with routine chlamydia testing, and the cost-effectiveness of various screening strategies. No new evidence was identified to address key questions for pregnant women and newborns.

Studies identified several individual-level risk factors for gonorrhea infection including young age (<25 years), African American race, multiple sex partners or an infected sex partner, inconsistent use of barrier contraceptives, previous or coexistent STDs, douching, use of drugs, and history of incarceration. No risk assessment criteria have been developed and tested in a screening population.

Social capital and geographic region of residence within a community may be important determinants of STD transmission dynamics at the population level and important risk factors for infection at the individual level. Studies demonstrated that the greatest differences in risk were along parameters that constitute the organizing features of society (e.g. race/ethnicity, age, and gender), rather than those that differentiate individual behaviors (e.g. numbers of partners). Studies using geographic analysis of STD incidence show different incidence rates in different subpopulations, with the highest rates occurring in poor, inner city, and densely populated contiguous census tracts. Simply cataloging risk behaviors and demographic and socioeconomic characteristics has not provided adequate description of STD transmission. For example, in high STD prevalence populations, individual sexual risk behaviors may have less of an influence on risk for infection than the characteristics of sexual partners. Rather than an indicator of high-risk behavior, low socioeconomic status may be a marker for involvement in high-risk sexual networks and a consequent greater likelihood of exposure to an infected partner.

Gonorrhea can be diagnosed by a number of new testing technologies, such as nucleic acid amplification tests and nucleic acid hybridization tests. These tests demonstrate high sensitivity and specificity, although studies are methodologically limited. Sensitivity is lower using urine

specimens for some tests, and may vary by symptom status. Urine tests and self-administered vaginal swabs provide a quick, non-invasive method of screening that can be implemented in non-traditional settings such as school-based clinics, substance abuse treatment programs, and job training programs.

Outcomes Table

Table 4 summarizes the effects of screening 10,000 women in low, moderate, and high-risk groups. In a low-risk population (prevalence=0.001) using a 95% sensitive test, if 10,000 women were screened, nearly 10 would be diagnosed and treated, preventing slightly more than 1 case of PID. The number needed to screen (NNS) to detect one case of gonorrhea would be 1,085, and the NNS to prevent one case of PID would be 7,751. As the prevalence of gonorrhea increases, the NNS to prevent cases of gonorrhea and PID decrease accordingly. In a population with a prevalence of 0.01, the NNS to detect one case of gonorrhea would be 109, and the NNS to prevent one case of PID would be 840.

Limitations of the Evidence

The evidence is limited by the descriptive, cross-sectional nature of the majority of the studies and the focus of research in high prevalence communities and settings, such as inner city STD clinics. Very few studies present data applicable to a general, asymptomatic population. Studies of tests are limited in many ways including use of inappropriate and dissimilar reference standards and populations. This heterogeneity prohibits meta-analysis or comparisons between tests.

Future Research

Studies are needed that provide evidence that screening is associated with decreased transmission and complications. These include studies to evaluate screening criteria for men, women, adolescents, pregnant women, and MSM in primary care and community-based settings to determine the effectiveness of various screening strategies. These strategies would include comparisons of universal, age-based, and risk factor-based criteria among populations with various prevalence rates. Also, studies should be coordinated to define representative populations that can be studied over time rather than continuing to report from isolated cross-sectional convenience samples. A prospective approach would allow correct assessment of the performance of screening criteria, important in a disease such gonorrhea whose epidemiology is dynamic. Research that examines population-level factors and association to STD transmission rather than focusing primarily on individual-level factors is warranted given the recent studies that highlight the importance of social capital and residence in high prevalence communities. Further, studies that integrate individual-level and population-level theories of sexual health and risk behavior and the development and implementation of methods of investigating risk within a multi-level, multi-causal framework are needed.

Additional research on the effectiveness of screening in community-based settings, including screening strategies using mailed specimens would be useful. This also includes further testing of the effectiveness of urine gonorrhea tests, as well as research on the role of asymptomatic infections in treatment and prevention strategies. Studies on the value of adding gonorrhea testing to routine chlamydia testing are needed. Cost-effectiveness studies of current clinical options such as screening criteria, types of diagnostic tests, and partner notification would be useful. Importantly, measurement of harms of screening and intervention should also be included

Acknowledgments

This update of the evidence was funded by the Agency for Healthcare Research and Quality (AHRQ) for the U.S. Preventive Services Task Force (USPSTF), and the investigators acknowledge the contributions of Gurvaneet Randhawa MD, MPH and David Lanier, MD, MPH, Task Order Officers, AHRQ and David Meyers, MD, Medical Officer, AHRQ. Members of the USPSTF who served as leads for this project include Kimberly D. Gregory, MD, MPH, Diana B. Petitti, MD, MPH, Jonathan D. Klein, MD, MPH, and Steven M. Teutsch, MD, MPH. Investigators thank the expert reviewers commenting on draft versions, Andrew Hamilton, MLS, MS for conducting the literature searches and Peggy Nygren, MA

References

1. U.S. Preventive Services Task Force. *Guide to Clinical Preventive Service*. 2nd ed. Office of Disease Prevention and Health Promotion; 1996.

2. Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance 2003 Supplement: Gonococcal Isolate Surveillance Project (GISP) Annual Report - 2003. Atlanta, GA: U.S. Department of Health and Human Services; November 2004.

3. Miller WC, Ford CA, Morris M, Handcock MS, Schmitz JL, Hobbs MM, et al. Prevalence of chlamydial and gonococcal infections among young adults in the United States. JAMA 2004;291(18):2229-36.

4. Kahn RH, Moseley KE, Thilges JN, Johnson G, Farley TA. Community-based screening and treatment for STDs: results from a mobile clinic initiative. Sex Transm Dis 2003;30(8):654-8.

5. Bachmann LH, Pigott D, Desmond R, Jones M, Lumpkins J, Gala P, et al. Prevalence and factors associated with gonorrhea and chlamydial infection in at-risk females presenting to an urban emergency department. Sex Transm Dis 2003;30(4):335-9.

6. Centers for Disease Control and Prevention. High prevalence of chlamydial and gonococcal infection in women entering jails and juvenile detention centers--Chicago, Birmingham, and San Francisco, 1998. JAMA 1999;282(15):1417-8.

7. Poulin C, Alary M, Bernier F, Ringuet J, Joly JR. Prevalence of Chlamydia trachomatis, Neisseria gonorrhoeae, and HIV infection among drug users attending an STD/HIV prevention and needle-exchange program in Quebec City, Canada. Sex Transm Dis 1999;26(7):410-20.

8. Liebschutz JM, Finley EP, Braslins PG, Christiansen D, Horton NJ, Samet JH. Screening for sexually transmitted infections in substance abuse treatment programs. Drug Alcohol Depend 2003;70(1):93-9.

9. Farley TA, Cohen DA, Elkins W. Asymptomatic sexually transmitted diseases: the case for screening. Prev Med 2003;36(4):502-9.

10. Cohen DA, Nsuami M, Brooks B, Martin DH. School-based screening for sexually transmitted diseases. J of LA STATE MED SOC 1999;151(12):617-21.

11. Orr DP, Johnston K, Brizendine E, Katz B, Fortenberry JD. Subsequent sexually transmitted infection in urban adolescents and young adults. Arch Pediatr Adolesc Med 2001;155(8):947-53.

12. Pack RP, Diclemente RJ, Hook EW, 3rd, Oh MK. High prevalence of asymptomatic STDs in incarcerated minority male youth: a case for screening. Sex Transm Dis 2000;27(3):175-7.

13. Wiesenfeld HC, Lowry DL, Heine RP, Krohn MA, Bittner H, Kellinger K, et al. Self-collection of vaginal swabs for the detection of chlamydia, gonorrhea, and trichomoniasis: opportunity to encourage sexually transmitted disease testing among adolescents. Sex Transm Dis 2001;28(6):321-5.

14. Mertz KJ, Finelli L, Levine WC, Mognoni RC, Berman SM, Fishbein M, et al. Gonorrhea in male adolescents and young adults in Newark, New Jersey: implications of risk factors and patient preferences for prevention strategies. Sex Transm Dis 2000;27(4):201-7.

15. Mertz KJ, Schwebke JR, Gaydos CA, Beidinger HA, Tulloch SD, Levine WC. Screening women in jails for chlamydial and gonococcal infection using urine tests: feasibility, acceptability, prevalence, and treatment rates. Sex Transm Dis 2002;29(5):271-6.

16. Centers for Disease Control and Prevention. Sexually Transmitted Diseases Treatment Guidelines 2002. MMWR - Morbidity & Mortality Weekly Report. 2002;51(RR-6).

17. Johnson RE, Newhall WJ, Papp JR, Knapp JS, Black CM, Gift TL, et al. Screening tests to detect Chlamydia trachomatis and Neisseria gonorrhoeae infections--2002. Morbidity & Mortality Weekly Report. Recommendations & Reports. 2002;51(RR-15):1-38; quiz CE1-4.

18. Cecil JA, Howell MR, Tawes JJ, Gaydos JC, McKee KT, Jr., Quinn TC, et al. Features of Chlamydia trachomatis and Neisseria gonorrhoeae infection in male Army recruits. J Infect Dis 2001;184(9):1216-9.

19. Farley TA, Cohen DA, Wu SY, Besch CL. The value of screening for sexually transmitted diseases in an HIV clinic. JAIDS 2003;33(5):642-8.

20. Centers for Disease Control and Prevention. Screening Tests To Detect Chlamydia trachomatis and Neisseria gonorrhoeae Infections — 2002. MMWR (No. RR-15). U.S. Department of Health and Human Services; 2002.

21. Sloan NL, Winikoff B, Haberland N, Coggins C, Elias C. Screening and syndromic approaches to

identify gonorrhea and chlamydial infection among women. Stud Fam Plann 2000;31(1):55-68.

22. Koumans EH, Johnson RE, Knapp JS, St Louis ME. Laboratory testing for Neisseria gonorrhoeae by recently introduced nonculture tests: a performance review with clinical and public health considerations. Clin Infect Dis 1998;27(5):1171-80.

23. Katz AR, Effler PV, Ohye RG, Brouillet B, Lee MV, Whiticar PM. False-positive gonorrhea test results with a nucleic acid amplification test: the impact of low prevalence on positive predictive value. Clin Infect Dis 2004;38(6):814-9.

24. Klausner J. The NAAT is out of the bag. Clin Infect Dis 2004;38(6):820-1.

25. St Lawrence JS, Montano DE, Kasprzyk D, Phillips WR, Armstrong K, Leichliter JS. STD screening, testing, case reporting, and clinical and partner notification practices: a national survey of US physicians. Am J Public Health 2002;92(11):1784-8.

26. Banikarim C, Chacko MR, Wiemann CM, Smith PB. Gonorrhea and chlamydia screening among young women: stage of change, decisional balance, and self-efficacy. J. Adolesc. Health 2003;32(4):288-95.

27. Gershman KA, Barrow JC. A tale of two sexually transmitted diseases. Prevalences and predictors of chlamydia and gonorrhea in women attending Colorado family planning clinics. Sex Transm Dis 1996;23(6):481-8.

28. Liau A, Diclemente RJ, Wingood GM, Crosby RA, Williams KM, Harrington K, et al. Associations between biologically confirmed marijuana use and laboratory-confirmed sexually transmitted diseases among African American adolescent females. Sex Transm Dis 2002;29(7):387-90.

29. Peters SE, Beck-Sague CM, Farshy CE, Gibson I, Kubota KA, Solomon F, et al. Behaviors associated with Neisseria gonorrhoeae and Chlamydia trachomatis: cervical infection among young women attending adolescent clinics. Clin Pediatr 2000;39(3):173-7.

30. Marrazzo JM, Handsfield HH, Whittington WL. Predicting chlamydial and gonococcal cervical infection: implications for management of cervicitis. Obstet Gynecol 2002;100(3):579-84.

31. Shain RN, Perdue ST, Piper JM, Holden AE, Champion JD, Newton ER, et al. Behaviors changed by intervention are associated with reduced STD recurrence: the importance of context in measurement. Sex Transm Dis 2002;29(9):520-9.

32. Katz AR, Effler PV, Ohye RG, Lee MV. Assessing age-related risk for gonococcal and chlamydial infections among females in Hawaii, 2001: a comparison of morbidity rates with screening test positivity. Ambul Pediatr 2004;4(2):188-91.

33. Katz BP, Fortenberry JD, Tu W, Harezlak J, Orr DP. Sexual behavior among adolescent women at high risk for sexually transmitted infections. Sex Transm Dis 2001;28(5):247-51.

34. Lifson AR, Halcon LL, Hannan P, St Louis ME, Hayman CR. Screening for sexually transmitted infections among economically disadvantaged youth in a national job-training program. J Adolesc Health 2001;28(3):190-6.

35. Mehta SD, Rothman RE, Kelen GD, Quinn TC, Zenilman JM. Unsuspected gonorrhea and chlamydia in patients of an urban adult emergency department: a critical population for STD control intervention. Sex Transm Dis 2001;28(1):33-9.

36. Boyer CB, Shafer MA, Teitle E, Wibbelsman CJ, Seeberg D, Schachter J. Sexually transmitted diseases in a health maintenance organization teen clinic: associations of race, partner's age, and marijuana use.[erratum appears in Arch Pediatr Adolesc Med 2000 May;154(5):433]. Arch Pediatr Adolesc Med. 1999;153(8):838-44.

37. Ellen JM, Langer LM, Zimmerman RS, Cabral RJ, Fichtner R. The link between the use of crack cocaine and the sexually transmitted diseases of a clinic population. A comparison of adolescents with adults. Sex Transm Dis 1996;23(6):511-6.

38. Schwebke JR, Desmond RA, Oh MK. Predictors of bacterial vaginosis in adolescent women who douche. Sex Transm Dis 2004;31(7):433-6.

39. Bloomfield PJ, Kent C, Campbell D, Hanbrook L, Klausner JD. Community-based chlamydia and gonorrhea screening through the United States mail, San Francisco. Sex Transm Dis 2002;29(5):294-7.

40. Sparks R, Helmers JR, Handsfield HH, Totten PA, Holmes KK, Wroblewski JK, et al. Rescreening for gonorrhea and chlamydial infection through the mail: a randomized trial. Sex Transm Dis 2004;31(2):113-6.

41. Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance 2002 Supplement: Gonococcal Isolate Surveillance Project (GISP) Annual Report - 2002. Atlanta, GA: U.S. Department of Health and Human Services; October 2003.

42. Centers for Disease Control and Prevention. Increases in fluoroquinolone-resistant Neisseria gonorrhoeae among men who have sex with men--United States, 2003, and revised recommendations

for gonorrhea treatment, 2004. MMWR. Morbidity & Mortality Weekly Report. 2004;53(16):335-8.

43. Acar J, Goldstein F. Trends in bacterial resistance to fluoroquinolones. Clin Infect Dis 1997;24(1):S67-73.

44. Harris RP, Helfand M, Woolf SH, Lohr KN, Mulrow CD, Teutsch SM, et al. Current methods of the U.S. Preventive Services Task Force: a review of the process. Am J Prev Med 2001;20(3 (suppl 1)):21-35.

45. Gunn RA, Fitzgerald S, Aral SO. Sexually transmitted disease clinic clients at risk for subsequent gonorrhea and chlamydia infections: possible 'core' transmitters. Sex Transm Dis 2000;27(6):343-9.

46. Klausner JD, Barrett DC, Dithmer D, Boyer CB, Brooks GF, Bolan G. Risk factors for repeated gonococcal infections: San Francisco, 1990-1992. J Infect Dis 1998;177(6):1766-9.

47. Todd CS, Haase C, Stoner BP. Emergency department screening for asymptomatic sexually transmitted infections. Am J Public Health 2001;91(3):461-4.

48. McKee KT, Jr., Jenkins PR, Garner R, Jenkins RA, Nannis ED, Hoffman IF, et al. Features of urethritis in a cohort of male soldiers. Clin Infect Dis 2000;30(4):736-41.

49. Oh MK, Cloud GA, Fleenor M, Sturdevant MS, Nesmith JD, Feinstein RA. Risk for gonococcal and chlamydial cervicitis in adolescent females: incidence and recurrence in a prospective cohort study. J Adolesc Health 1996;18(4):270-5.

50. Ellen JM, Hessol NA, Kohn RP, Bolan GA. An investigation of geographic clustering of repeat cases of gonorrhea and chlamydial infection in San Francisco, 1989-1993: evidence for core groups. J Infect Dis 1997;175(6):1519-22.

51. Holtgrave DR, Crosby RA. Social capital, poverty, and income inequality as predictors of gonorrhoea, syphilis, chlamydia and AIDS case rates in the United States. Sex Transm Infect 2003;79(1):62-4.

52. Cohen D, Spear S, Scribner R, Kissinger P, Mason K, Wildgen J. "Broken windows" and the risk of gonorrhea. Am J Public Health 2000;90(2):230-236.

53. Becker K, Glass G, Brathwaite W, Zenilman J. Geographic epidemiology of gonorrhea in Baltimore, Maryland, using a geographic information system. Am J Epidemiol 1998;147:709-16.

54. Tabrizi SN, Chen S, Cohenford MA, Lentrichia BB, Coffman E, Shultz T, et al. Evaluation of real time polymerase chain reaction assays for confirmation of Neisseria gonorrhoeae in clinical samples tested positive in the Roche Cobas Amplicor assay. Sex Transm Infect 2004;80(1):68-71.

55. Leslie DE, Azzato F, Ryan N, Fyfe J. An assessment of the Roche Amplicor Chlamydia trachomatis/Neisseria gonorrhoeae multiplex PCR assay in routine diagnostic use on a variety of specimen types. Commun Dis Intell. 2003;27(3):373-9.

56. Van Der Pol B, Ferrero DV, Buck-Barrington L, Hook E, 3rd, Lenderman C, Quinn T, et al. 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 2001;39(3):1008-16.

57. Livengood CH, 3rd, Wrenn JW. Evaluation of COBAS AMPLICOR (Roche): accuracy in detection of Chlamydia trachomatis and Neisseria gonorrhoeae by coamplification of endocervical specimens. J Clin Microbiol 2001;39(8):2928-32.

58. Darwin LH, Cullen AP, Crowe SR, Modarress KJ, Willis DE, Payne WJ. Evaluation of the Hybrid Capture 2 CT/GC DNA tests and the GenProbe PACE 2 tests from the same male urethral swab specimens. Sex Transm Dis 2002;29(10):576-80.

59. Diemert DJ, Libman MD, Lebel P. Confirmation by 16S rRNA PCR of the COBAS AMPLICOR CT/NG test for diagnosis of Neisseria gonorrhoeae infection in a low-prevalence population. J Clin Microbiol 2002;40(11):4056-9.

60. van Doornum GJ, Schouls LM, Pijl A, Cairo I, Buimer M, Bruisten S. Comparison between the LCx Probe system and the COBAS AMPLICOR system for detection of Chlamydia trachomatis and Neisseria gonorrhoeae infections in patients attending a clinic for treatment of sexually transmitted diseases in Amsterdam, The Netherlands. J Clin Microbiol 2001;39(3):829-35.

61. Farrell DJ, Sheedy TJ. Urinary screening for Neisseria gonorrhoeae in asymptomatic individuals from Queensland, Australia: an evaluation using three nucleic acid amplification methods. Pathology 2001;33(2):204-5.

62. Palladino S, Pearman JW, Kay ID, Smith DW, Harnett GB, Woods M, et al. Diagnosis of Chlamydia trachomatis and Neisseria gonorrhoeae. Genitourinary infections in males by the Amplicor PCR assay of urine. Diagn Microbiol Infect Dis 1999;33(3):141-6.

63. Modarress KJ, Cullen AP, Jaffurs WJ, Sr., Troutman GL, Mousavi N, Hubbard RA, et al. Detection of Chlamydia trachomatis and Neisseria

gonorrhoeae in swab specimens by the Hybrid Capture II and PACE 2 nucleic acid probe tests. Sex Transm Dis 1999;26(5):303-8.

64. Schachter J, Hook EW, 3rd, McCormack WM, Quinn TC, Chernesky M, Chong S, et al. Ability of the digene hybrid capture II test to identify Chlamydia trachomatis and Neisseria gonorrhoeae in cervical specimens. J Clin Microbiol 1999;37(11):3668-71.

65. Cosentino LA, Landers DV, Hillier SL. Detection of Chlamydia trachomatis and Neisseria gonorrhoeae by strand displacement amplification and relevance of the amplification control for use with vaginal swab specimens. J Clin Microbiol 2003;41(8):3592-6.

66. Uhrin M. Molecular diagnostics. The polymerase chain reaction and its use in the diagnosis of Chlamydia trachomatis and Neisseria gonorrhoeae. Gac Med Mex 1997;133(Suppl 1):133-7.

67. Young H, Anderson J, Moyes A, McMillan A. Non-cultural detection of rectal and pharyngeal gonorrhoea by the Gen-Probe PACE 2 assay. Genitourin Med 1997;73(1):59-62.

68. Roymans R, Onland G, Jansz A, Quint W, Boel E. Evaluation of an in-house polymerase chain reaction for detection of Neisseria gonorrhoeae in urogenital samples. J Clin Pathol 1999;52(6):411-4.

69. Bassiri M, Mardh PA, Domeika M. Multiplex AMPLICOR PCR screening for Chlamydia trachomatis and Neisseria gonorrhoeae in women attending non-sexually transmitted disease clinics. The European Chlamydia Epidemiology Group. J Clin Microbiol 1997;35(10):2556-60.

70. Crotchfelt KA, Welsh LE, DeBonville D, Rosenstraus M, Quinn TC. Detection of Neisseria gonorrhoeae and Chlamydia trachomatis in genitourinary specimens from men and women by a coamplification PCR assay. J Clin Microbiol 1997;35(6):1536-40.

71. Beltrami JF, Farley TA, Hamrick JT, Cohen DA, Martin DH. Evaluation of the Gen-Probe PACE 2 assay for the detection of asymptomatic Chlamydia trachomatis and Neisseria gonorrhoeae infections in male arrestees. Sex Transm Dis 1998;25(10):501-4.

72. Chan EL, Brandt K, Olienus K, Antonishyn N, Horsman GB. Performance characteristics of the Becton Dickinson ProbeTec System for direct detection of Chlamydia trachomatis and Neisseria gonorrhoeae in male and female urine specimens in comparison with the Roche Cobas System. Arch Pathol Lab Med 2000;124(11):1649-52.

73. Schwebke JR, Zajackowski ME. Comparison of DNA probe (Gen-Probe) with culture for the detection of Neisseria gonorrhoeae in an urban STD programme. Genitourin Med 1996;72(2):108-10.

74. Whiley DM, LeCornec GM, Mackay IM, Siebert DJ, Sloots TP. A real-time PCR assay for the detection of Neisseria gonorrhoeae by LightCycler. Diagn Microbiol Infect Dis 2002;42(2):85-9.

75. Darwin LH, Cullen AP, Arthur PM, Long CD, Smith KR, Girdner JL, et al. Comparison of Digene hybrid capture 2 and conventional culture for detection of Chlamydia trachomatis and Neisseria gonorrhoeae in cervical specimens. J Clin Microbiol 2002;40(2):641-4.

76. Martin DH, Cammarata C, Van Der Pol B, Jones RB, Quinn TC, Gaydos CA, et al. Multicenter evaluation of AMPLICOR and automated COBAS AMPLICOR CT/NG tests for Neisseria gonorrhoeae. J Clin Microbiol 2000;38(10):3544-9.

77. Moncada J, Schachter J, Hook EW, 3rd, Ferrero D, Gaydos C, Quinn TC, et al. The effect of urine testing in evaluations of the sensitivity of the Gen-Probe Aptima Combo 2 assay on endocervical swabs for Chlamydia trachomatis and Neisseria gonorrhoeae: the infected patient standard reduces sensitivity of single site evaluation. Sex Transm Dis 2004;31(5):273-7.

78. Gaydos CA, Quinn TC, Willis D, Weissfeld A, Hook EW, Martin DH, et al. 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 2003;41(1):304-309.

79. Page-Shafer K, Graves A, Kent C, Balls JE, Zapitz VM, Klausner JD. Increased sensitivity of DNA amplification testing for the detection of pharyngeal gonorrhea in men who have sex with men. Clin Infect Dis 2002;34(2):173-6.

80. Rietmeijer CA, Patnaik JL, Judson FN, Douglas JM, Jr. Increases in gonorrhea and sexual risk behaviors among men who have sex with men: a 12-year trend analysis at the Denver Metro Health Clinic. Sex Transm Dis 2003;30(7):562-7.

81. Centers for Disease Control and Prevention. Increases in unsafe sex and rectal gonorrhea among men who have sex with men--San Francisco, California, 1994-1997. JAMA 1999;281(8):696-7.

82. Cook RL, St George K, Silvestre AJ, Riddler SA, Lassak M, Rinaldo CR, Jr. Prevalence of chlamydia and gonorrhoea among a population of men who have sex with men. Sex Transm Infect 2002;78(3):190-3.

83. Lafferty WE, Hughes JP, Handsfield HH. Sexually transmitted diseases in men who have sex with men. Acquisition of gonorrhea and nongonococcal

urethritis by fellatio and implications for STD/HIV prevention. Sex Transm Dis 1997;24(5):272-8.

84. Kim AA, Kent CK, Klausner JD. Risk factors for rectal gonococcal infection amidst resurgence in HIV transmission. Sex Transm Dis 2003;30(11):813-7.

85. Mehta SD, Bishai D, Howell MR, Rothman RE, Quinn TC, Zenilman JM. Cost-effectiveness of five strategies for gonorrhea and chlamydia control among female and male emergency department patients. Sex Transm Dis 2002;29(2):83-91.

86. Gift T, Walsh C, Haddix A, Irwin KL. A cost-effectiveness evaluation of testing and treatment of Chlamydia trachomatis infection among asymptomatic women infected with Neisseria gonorrhoeae. Sex Transm Dis 2002;29(9):542-51.

87. Centers for Disease Control and Prevention. 1998 Guidelines for treatment of sexually transmitted diseases. MMWR - Morbidity & Mortality Weekly Report. 1998;47(RR-1):1-116.

88. American College of Obstetricians and Gynecologists. Gonorrhea and chlamydial infections. ACOG Technical Bulletin Number 190-March 1994 (replaces No. 89, November 1985). Int J Gynaecol Obstet 1994;45(2):169-74.

89. Miller JM, Jr., Maupin RT, Mestad RE, Nsuami M. Initial and repeated screening for gonorrhea during pregnancy. Sex Transm Dis 2003;30(9):728-30.

90. Magriples U, Copel JA. Can risk factor assessment replace universal screening for gonorrhea and Chlamydia in the third trimester? Am J of Perinat 2001;18(8):465-8.

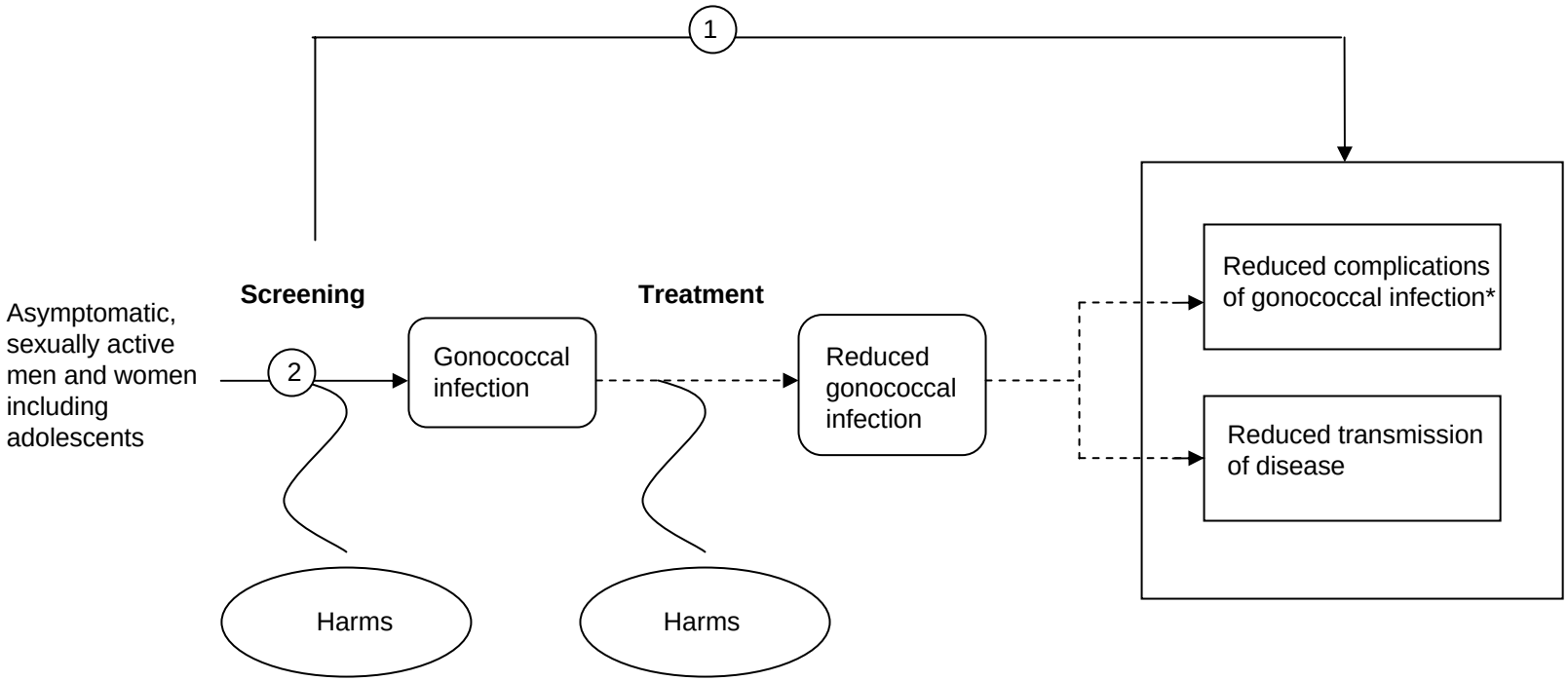
This study was conducted by the Oregon Evidence-based Practice Center under contract to the Agency for Healthcare Research and Quality (AHRQ) Contract #290-02-0024, Rockville, MD.

Address correspondence to Nancy Glass, Oregon Evidence-based Practice Center, 3181 SW Sam Jackson Park Road, Portland, OR 97239.

Reprints of this article and the corresponding recommendation statement are available from the AHRQ Web site (www.preventiveservices.ahrq.gov). The recommendation is also posted on the Web site of the National Guideline Clearinghouse™ (www.guideline.gov).

AHRQ Publication No. 05-0579-B
May 2005

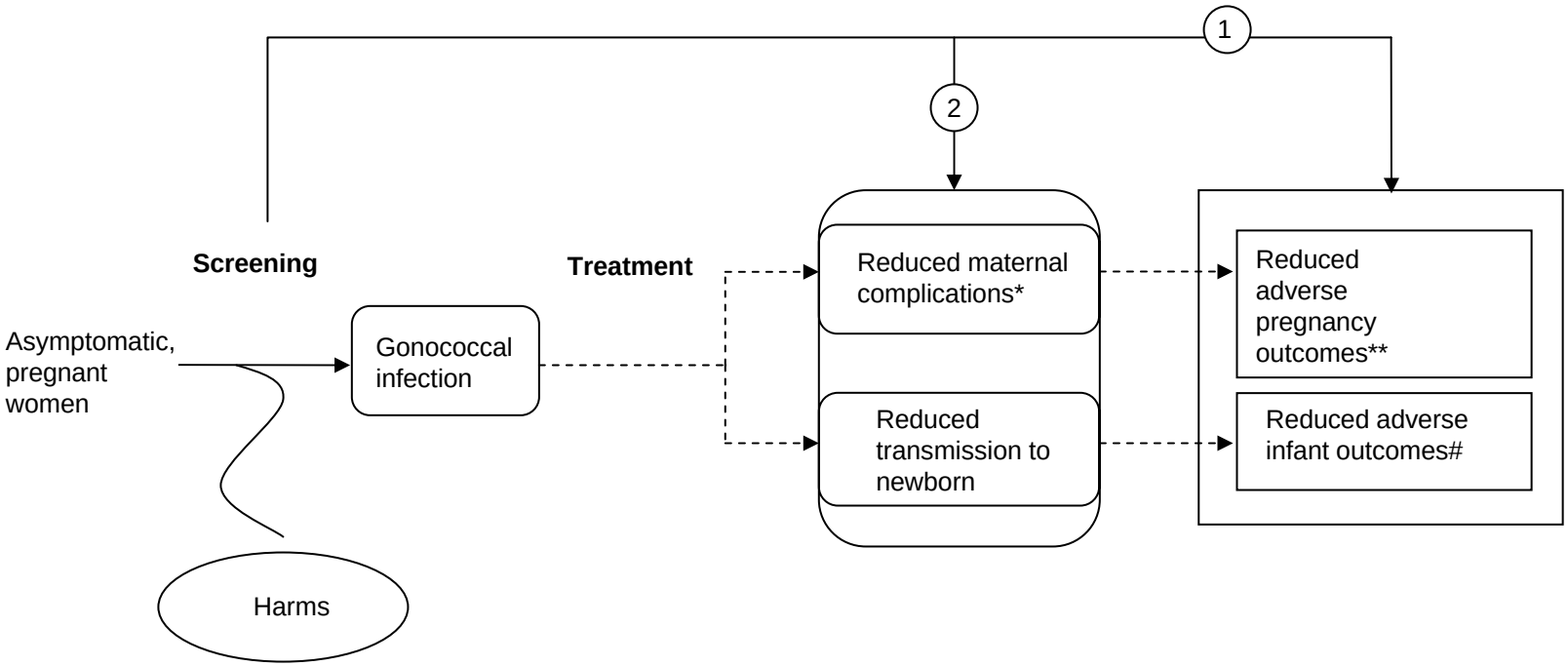
FIGURE 1. ANALYTIC FRAMEWORK
Screening for Gonorrhea in Asymptomatic Men and Women Including Adolescents



*Pelvic inflammatory disease, ectopic pregnancy, infertility, chronic pelvic pain for women; epididymitis, prostatitis, urethritis for men; and disseminated gonococcal infection (e.g. tenosynovitis, arthritis, endocarditis, meningitis).

---- Dotted line indicates that an evidence link is well-established and will not be evaluated in this review.

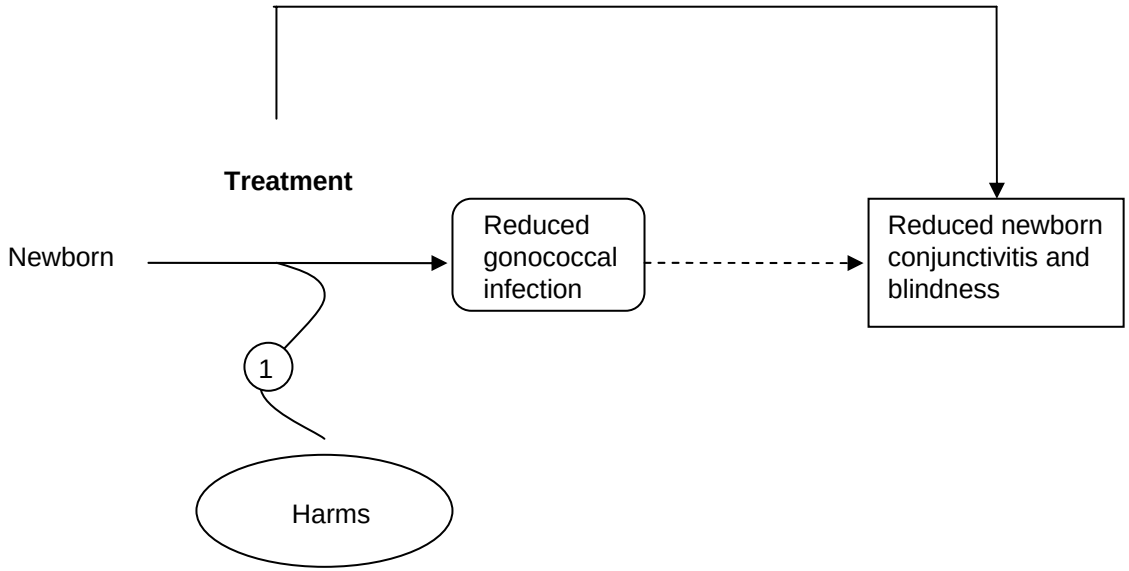
FIGURE 2. ANALYTIC FRAMEWORK
Screening for Gonorrhea in Pregnant Women



*Chorioamnionitis, premature rupture of membranes, preterm labor.
**Septic abortion, stillbirth, preterm delivery/low birth weight.
Gonococcal conjunctivitis, blindness.

---- Dotted line indicates that an evidence link is well-established and will not be evaluated in this review.

FIGURE 3. ANALYTIC FRAMEWORK
Chemoprophylaxis for Newborn Gonococcal Infection



- - - - Dotted line indicates that an evidence link is well-established and will not be evaluated in this review.

FIGURE 4. TESTS USING CERVICAL SPECIMENS IN WOMEN

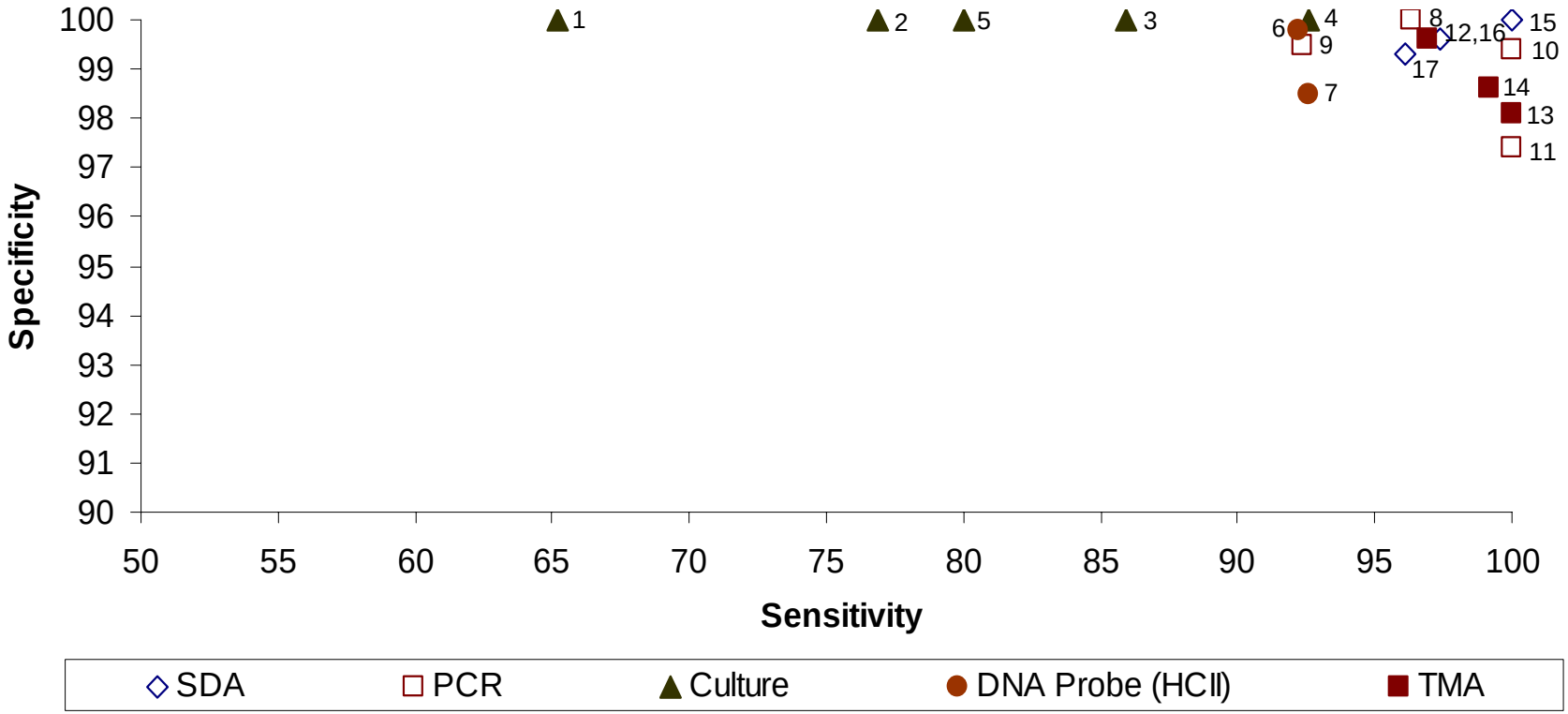
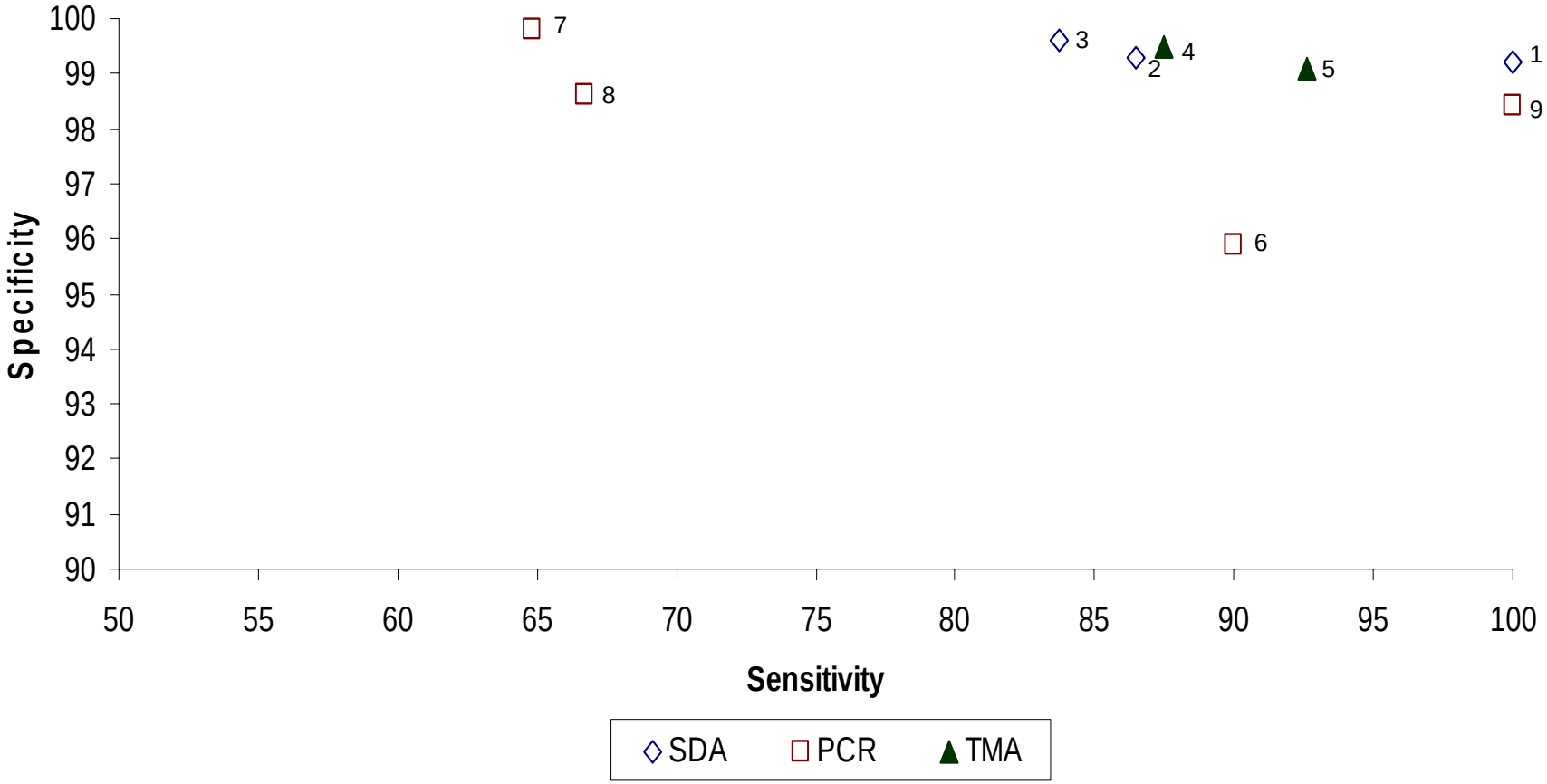


FIGURE 4B. DATA KEY FOR TESTS USING CERVICAL SPECIMENS IN WOMEN

1 Culture (Crotchfelt, 1997): Sensitivity = 65.2%, Specificity = 100%
2 Culture (Cosentino, 2003): Sensitivity = 76.9%, Specificity = 100%
3 Culture (Moncada, 2004): Sensitivity = 85.9%, Specificity = 100%
4 Culture (Livengood, 2001): Sensitivity = 92.6%, Specificity = 100%
5 Culture (Darwin, 2002a): Sensitivity = 80%, Specificity = 100%
6 DNA Probe (Darwin 2002a): Sensitivity = 92.2%, Specificity = 99.8%
7 DNA Probe (Schachter, 1999): Sensitivity = 92.6%, Specificity = 98.5%
8 PCR (Livengood, 2001): Sensitivity = 96.3%, Specificity = 100%
9 PCR (Martin, 2000): Sensitivity = 92.4%, Specificity = 99.5%
10 PCR (Crotchfelt, 1997): Sensitivity = 100%, Specificity = 99.4%
11 PCR (Van Doornum, 2001): Sensitivity = 100%, Specificity = 97.4%
12 TMA (Gaydos, 2003): Asymptomatic—Sensitivity = 96.9%, Specificity = 99.6%
13 TMA (Gaydos, 2003): Symptomatic—Sensitivity = 100%, Specificity = 98.1%
14 TMA (Moncada, 2004): Sensitivity = 99.2%, Specificity = 98.6%
15 SDA (Van der Pol, 2001): Asymptomatic—Sensitivity = 97.4%, Specificity = 99.6%
16 SDA (Van der Pol, 2001): Symptomatic—Sensitivity = 96.1%, Specificity = 99.3%
17 SDA (Cosentino, 2003): Sensitivity = 100%, Specificity = 100%

PCR, polymerase chain reaction; SDA, strand displacement amplification; TMA, transcription-mediated amplification.

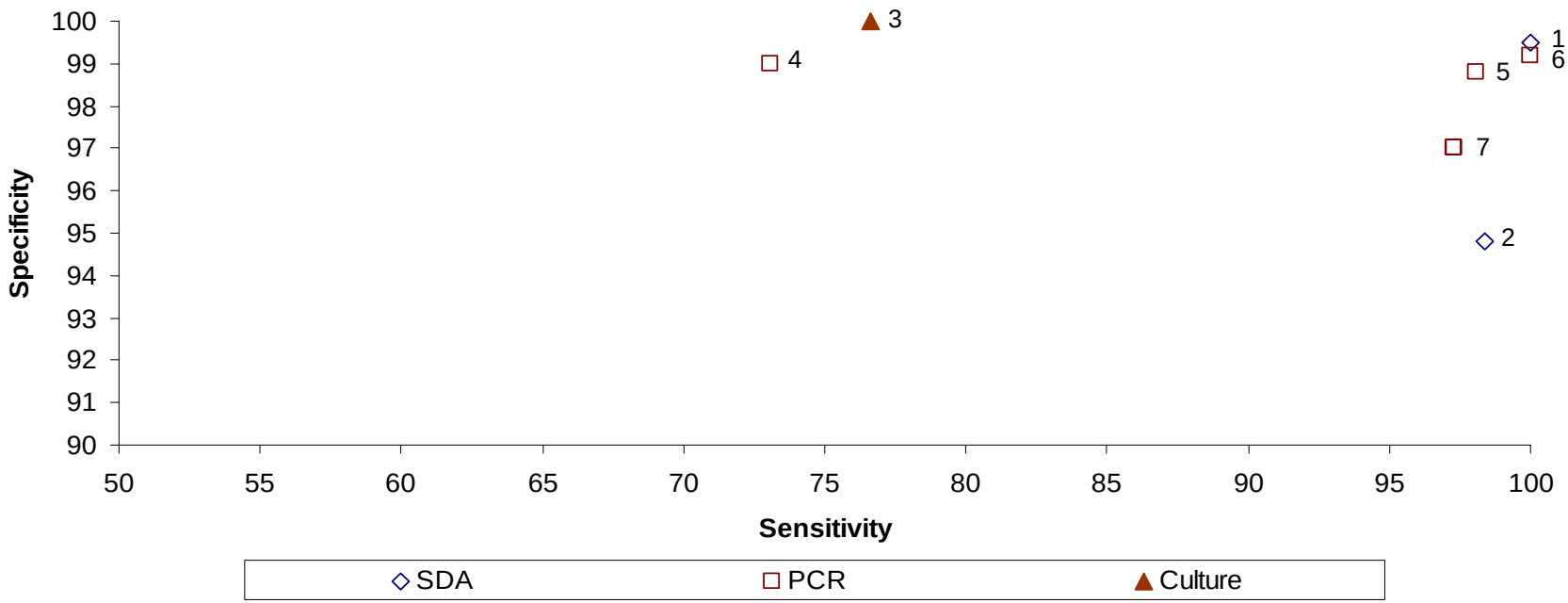
FIGURE 5. TESTS USING URINE SPECIMENS IN WOMEN



1 SDA (Chan, 2000): Sensitivity = 100%, Specificity = 99.2%
2 SDA (Van der Pol, 2001): Asymptomatic—Sensitivity = 86.5%, Specificity = 99.3%
3 SDA (Van der Pol, 2001): Symptomatic—Sensitivity = 83.7%, Specificity = 99.6%
4 TMA (Gaydos, 2003): Asymptomatic—Sensitivity = 87.5%, Specificity = 99.5%
5 TMA (Gaydos, 2003): Symptomatic—Sensitivity = 92.6%, Specificity = 99.1%
6 PCR (Crotchfelt, 1997): Sensitivity = 90.0%, Specificity = 95.9%
7 PCR (Martin, 2000): Sensitivity = 64.8%, Specificity = 99.8%
8 PCR (Van Doornum, 2001): Sensitivity = 66.7%, Specificity = 98.6%
9 PCR (Chan, 2000): Sensitivity = 100%, Specificity = 98.4%

PCR, polymerase chain reaction; SDA, strand displacement amplification; TMA, transcription mediated amplification.

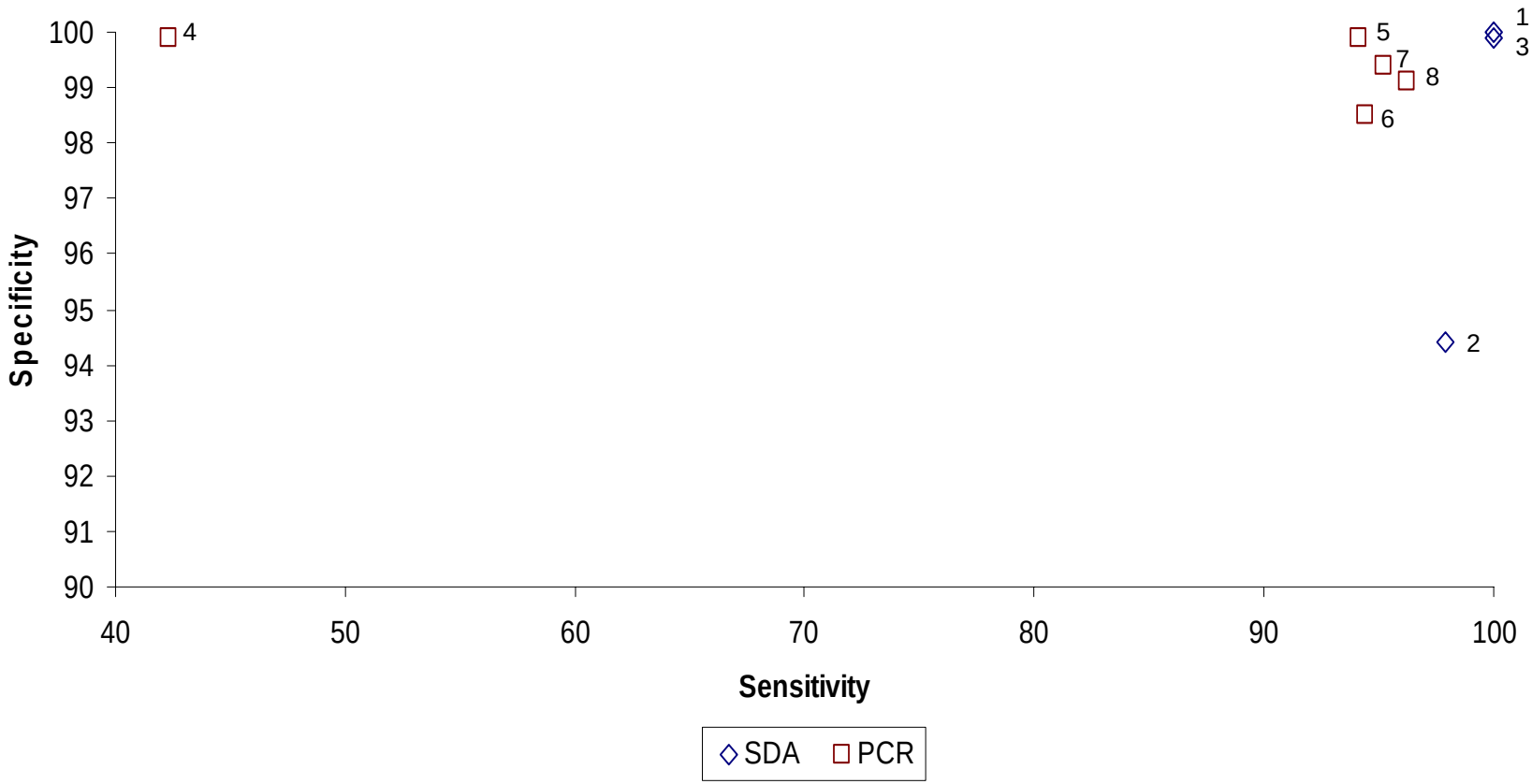
FIGURE 6. TESTS USING URETHRAL SPECIMENS IN MEN



1 SDA (Van der Pol, 2001): Asymptomatic—Sensitivity = 100%, Specificity = 99.5%
2 SDA (Van der Pol, 2001): Symptomatic—Sensitivity = 98.4%, Specificity = 94.8%
3 Culture (Crotchfelt, 1997): Sensitivity = 76.6, Specificity = 100%
4 PCR (Martin, 2000): Asymptomatic—Sensitivity = 73.1%, Specificity = 99.0%
5 PCR (Martin, 2000): Symptomatic—Sensitivity = 98.1%, Specificity = 98.8%
6 PCR (Van Doornum, 2001): Sensitivity = 100%, Specificity = 99.2%
7 PCR (Crotchfelt, 1997): Sensitivity = 97.3%, Specificity = 97.0%

PCR, polymerase chain reaction; SDA, strand displacement amplification; TMA, transcription mediated amplification.

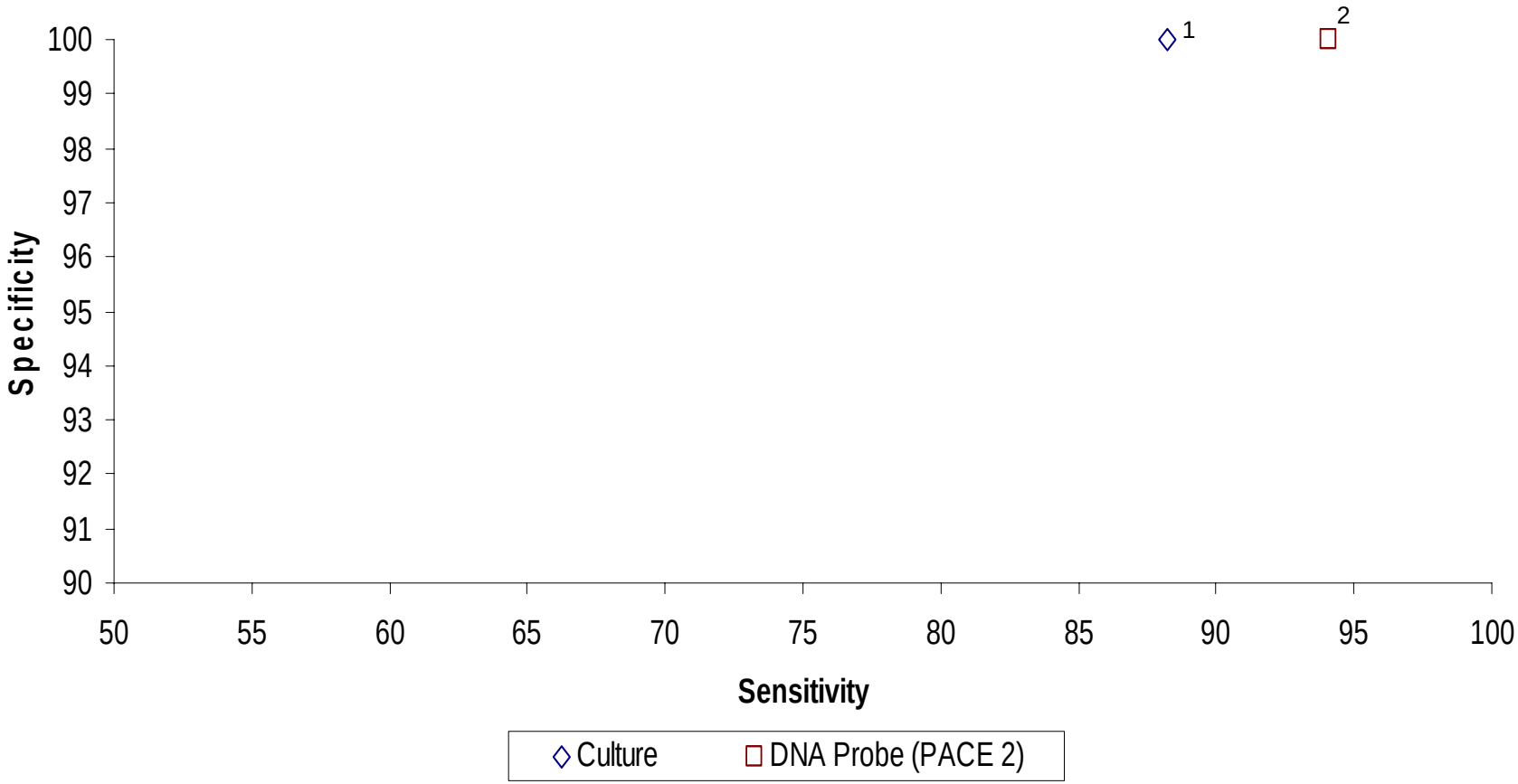
FIGURE 7. TESTS USING URINE SPECIMENS IN MEN



1 SDA (Van der Pol, 2001): Asymptomatic—Sensitivity = 100%, Specificity = 100%
2 SDA (Van der Pol, 2001): Symptomatic—Sensitivity = 97.9%, Specificity = 94.4%
3 SDA (Chan, 2000): Sensitivity = 100%, Specificity = 99.9%
4 PCR (Martin, 2000): Asymptomatic—Sensitivity = 42.3%, Specificity = 99.9%
5 PCR (Martin, 2000): Symptomatic—Sensitivity = 94.1%, Specificity = 99.9%
6 PCR (Crotchfelt, 1997): Sensitivity = 94.4%, Specificity = 98.5%
7 PCR (Van Doornum, 2001): Sensitivity = 95.2%, Specificity = 99.4%
8 PCR (Chan, 2000): Sensitivity = 96.2%, Specificity = 99.1%

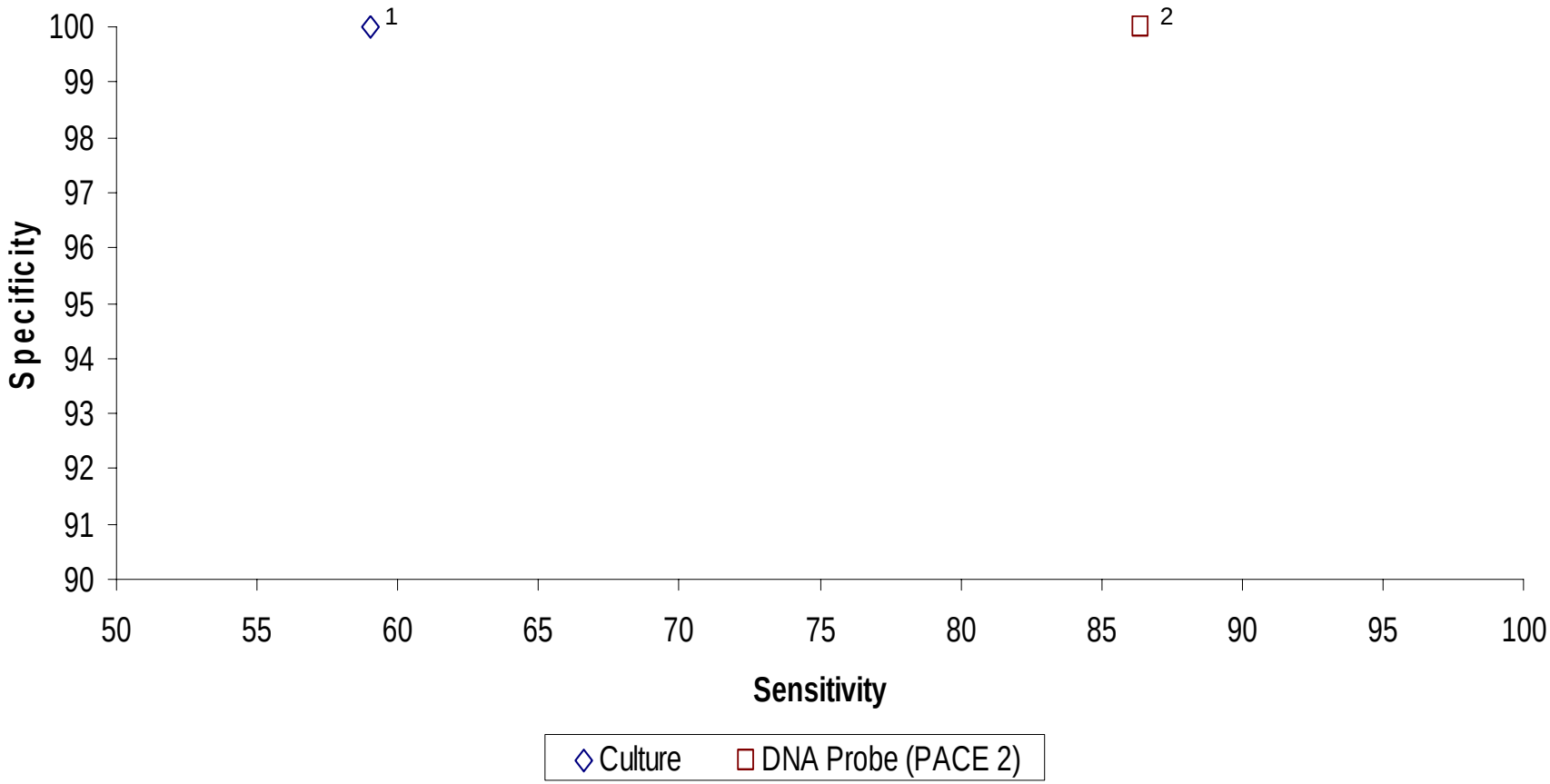
PCR, polymerase chain reaction; SDA, strand displacement amplification.

FIGURE 8. TESTS USING RECTAL SPECIMENS IN MEN WHO HAVE SEX WITH MEN



1 Culture (Young, 1997): Sensitivity = 88.2%, Specificity = 100%
2 DNA Probe (Young, 1997): Sensitivity = 94.1%, Specificity = 100%

FIGURE 9. TESTS USING PHARYNGEAL SPECIMENS IN MEN WHO HAVE SEX WITH MEN



1 Culture (Young, 1997): Sensitivity = 59.0%, Specificity = 100%
2 DNA Probe (Young, 1997): Sensitivity = 86.4%, Specificity = 100%

TABLE 1. COMPARISON OF COMMERCIAL GONORRHEA TESTS*

	Nucleic Acid Amplification Tests			Nucleic Acid Hybridization Tests		Culture
Test	**Polymerase Chain Reaction (PCR)** Amplicor™ Cobas Amplicor™	**Strand Displacement Amplification (SDA)** BDProbeTec™	**Transcription Mediated Amplification (TMA)** APTIMA® Combo 2	**DNA Probe** Hybrid Capture® II	**DNA Probe** PACE® 2	**Culture**
Manufacturer	Roche Diagnostics Corporation Basel, Switzerland	Becton, Dickinson and Company Franklin Lakes, NJ	Gen-Probe, Inc. San Diego, CA	Digene Corporation Gaithersburg, MD	Gen-Probe, Inc. San Diego, CA	NA
Advantages/ disadvantages	High sensitivity; use of urine specimens provides less invasive collection method	High sensitivity; use of urine specimens provides less invasive collection method	High sensitivity; use of urine specimens provides less invasive collection method; identification tests can be used as follow-up or direct tests	Identification tests can be used as follow-up or direct tests	Low sensitivity; requires confirmation testing	Poor sensitivity; can be used for antibiotic resistance testing
Combined chlamydia/ gonorrhea test	Yes	Yes	Yes	Yes	Yes	No
Sensitivity	66.7 - 100%	86.3 - 100%	96.9 - 99.2%	92.2 - 100%	54.0 - 99.4%	61.8 - 92.6%
Specificity	93.9 - 100%	96.0 - 100%	98.6 - 99.6%	96.8 - 100%	99.5 - 100%	100%
Collection method	Endocervical swabs for women, urethral swabs for men, or urine for both	Endocervical swabs for women, urethral swabs for men, or urine for both	Endocervical swabs for women, urethral swabs for men, or urine for both	Cervical brushes for women, urethral swabs for men	Endocervical swabs for women, urethral swabs for men	Endocervical swabs for women, urethral swabs for men
Test location	Laboratory	Laboratory	Laboratory	Laboratory	Laboratory	Laboratory

NA, not available.

TABLE 1. COMPARISON OF COMMERCIAL GONORRHEA TESTS*

*"The majority of commercial NAATs have been cleared† by the Food and Drug Administration (FDA) to detect C. trachomatis and N. gonorrhoeae in endocervical swabs from women, urethral swabs from men, and urine from both men and women. In addition, other specimens (e.g., those from the vagina and eye) have been used with satisfactory performance, although these applications have not been cleared by FDA. Testing of rectal and oropharyngeal specimens with NAATs has had limited evaluation and is not recommended."[20]

†"The term cleared is used by the Food and Drug Administration (FDA) to describe the process they use to review applications to market the class of diagnostic tests that includes C. trachomatis and N. gonorrhoeae tests discussed in these guidelines. The term approved is used by FDA to describe a more rigorous process they use to review applications to market classes of diagnostic tests that involve, for example, higher levels of risk if the test result is erroneous than is the case for C. trachomatis or N. gonorrhoeae."[20]

TABLE 2. SUMMARY OF INDIVIDUAL-LEVEL RISK FACTORS

Author, Year	Bachmann, 2003[5] N=403	Boyer, 1999[36] N=285	Cecil, 2001[18] N=2,24	Ellen, 1996[37] N=1,44	Gunn, 2000[45] N=2,57	Klausner, 1998[46] N=185	Liau, 2002[28] N=522	Marrazzo, 2002[30] N=6,239	Mehta, 2001[35] N=700	Mertz, 2000[14] N=214	Mertz, 2002[15] N=5,364	O 20(N=
Prevalence in study population												
Men only			0.1%	35%					4.0%	29-41%		
Women only	5%			13%				2%	6%		8-9%	
Men and women					<1%	100%			5%			22
STD co-infection	2%	29%	8%		3%		28%		14%			7
Demographic factors												
Age <21		X	0	X				X		X		
Age ≤25	X		0						X		X	
Less education						X						
Unemployment												
On public assistance												
High morbidity community												
African American	X	X				X		X		X		
Non-white								X				
Female												X
Individual-level factors												
Inconsistent/no barrier use	0	0	0	X*	0		X			X		(
Pregnant							0					
Oral contraception use							0					
Recent sexual activity	X	0	0	0						X		
Sex with an older partner		X										
Rapid partner turnover (3 mths)			0					0				X
Number of recent sex partners	X							X	X			X

TABLE 2. SUMMARY OF INDIVIDUAL-LEVEL RISK FACTORS

Author, Year	Bachmann, 2003[5] N=403	Boyer, 1999[36] N=285	Cecil, 2001[18] N=2,24	Ellen, 1996[37] N=1,44	Gunn, 2000[45] N=2,57	Klausner, 1998[46] N=185	Liau, 2002[28] N=522	Marrazzo, 2002[30] N=6,239	Mehta, 2001[35] N=700	Mertz, 2000[14] N=214	Mertz, 2002[15] N=5,364	O 20(N=
Number of lifetime sexual partners		0			0							(
Partner with STD/symptoms						0						
History of STD	0		X		X	X			X			(
History of PID	X											
Antibiotic use in previous 4 weeks	0											
Genitourinary symptoms	0											
Penile discharge									X			
Unable to name health care provider	X											
Emergency care use in past year												
Emergency care because of violence	0											
Previous HIV testing												
Sex with a commercial sex												
Douching												
Incarceration										X	X	
Substance use by self or partner	0	X		X*	0	0	X		X*	X		(

X=Factor is associated with higher risk for gonorrhea
0=Factor not associated with risk for gonorrhea
Blank=Factor not reported in study
STD=Sexually transmitted disease
PID=Pelvic inflammatory disease
*Risk factor for men only.

TABLE 3. SUMMARY OF EVIDENCE

Key Question	Level of Evidence	Conclusions	Int Va
Asymptomatic Men and Women Including Adolescents			
1A. Does screening women reduce complications and transmission of disease?	No studies		
1B. Does screening men reduce complications and transmission of disease?	No studies		
2A. What individual-level risk factors identify groups at higher risk for gonococcal infection?	15 descriptive studies	Age is the strongest predictor of gonococcal infection (<25 years). Additional risk factors include African American race, having multiple sex partners or an infected sex partner, inconsistent use of barrier contraceptives, previous or coexistent STDs, douching, use of drugs, and history of incarceration.	Not
2B. What population-level characteristics identify groups at higher risk for gonococcal infection?	4 descriptive studies	Contextual risk factors include sexual networks, sexual mixing within a community or neighborhood with high prevalence of STDs, and residence in a community with limited social capital or markers of physical deterioration.	Not
2C. What individual-level risk factors identify groups at higher risk for gonococcal infection when used in conjunction with population-level or provider-level characteristics?	No studies		
2D. What are the screening tests and their performance characteristics?	25 studies	NAATs: PCR sensitivity 42%-100%/specificity 96%-100%; SDA 84%-100%/95%-100%; TMA 88%-100%/98%-99.6%. DNA probes: 92%-93%/99%-99.8%.	I

TABLE 3. SUMMARY OF EVIDENCE

Key Question	Level of Evidence	Conclusions	Int Va
2E and 2F. What is the yield of screening in different risk populations? Does performance of screening tests vary by specimen type?	25 studies	NAATs: Women—high sensitivity/specificity with endocervical swab, decreased sensitivity with urine (PCR, TMA, SDA). Men—high sensitivity/specificity with urethral swab, decreased sensitivity with urine (PCR but not SDA). For both men and women—sensitivity may vary depending on symptom status. DNA probes: Using PACE® 2, sensitivity higher than culture for rectal and pharyngeal specimens.	I
2G. What is the role of screening for gonococcal infection among men who have sex with men (MSM)?	No studies		
3A. What is the evidence on cost-effectiveness for universal vs. targeted strategies?	1 decision analysis	Screening all women aged 18-31 years is more cost-effective than selective screening even when the combined prevalence of gonorrhea and chlamydia is 7%-17.5%. For men, standard practice (e.g., history and examination) is more cost-saving than enhanced screening strategies.	Not
3B. Are dual chlamydia-gonorrhea screening tests cost-effective?	No studies		
Pregnant Women			
1A. Does screening reduce adverse maternal/pregnancy outcomes (septic abortion, stillbirth, preterm delivery/low birth weight)?	No studies		
1B. Does screening reduce adverse neonatal outcomes (gonococcal conjunctivitis, blindness)?	No studies		
2A. Does screening reduce maternal complications (chorioamnionitis, premature rupture of membranes, preterm labor)?	No studies		

TABLE 3. SUMMARY OF EVIDENCE

Key Question	Level of Evidence	Conclusions	Int Va
2B. Does screening reduce transmission to the newborn?	No studies		
3. What is the evidence on cost-effectiveness for universal vs. targeted strategies?	No studies		
Newborn Chemoprophylaxis			
1. What are the adverse effects of treatment?	No studies		

NAATs, nucleic acid amplification tests; PCR, polymerase chain reaction; STD, sexually transmitted disease; SDA, strand displacement amplification; TMA, transcription-mediated amplification.

TABLE 4. SCREENING FOR GONORRHEA IN 10,000 WOMEN

	Gonorrhea Prevalence in Population or Risk Group				
Assumptions	**Low**	**Moderate**			**High**
Prevalence of gonorrhea	0.001	0.01	0.05	0.1	0.2
Sensitivity of test	0.95	0.95	0.95	0.95	0.9
Specificity of test	0.99	0.99	0.99	0.99	0.9
Effectiveness of antibiotic treatment*	0.97	0.97	0.97	0.97	0.9
Probability of PID in untreated infection*	0.20	0.20	0.20	0.20	0.2
Probability of PID in successfully treated infectior	0.06	0.06	0.06	0.06	0.0
Results					
Tested for gonorrhea	10,000	10,000	10,000	10,000	10,0
Cases of gonorrhea diagnosed	9.5	95	475	950	1,90
Cases of PID expected without treatment	2	20	100	200	40
Cases of gonorrhea successfully treated	9.2	92	461	922	1,84
Cases of PID expected with treatment	0.6	6	28	55	11
Cases of untreated infections (either undetected or unsuccessfully treated)	0.8	8	39	79	157
Cases of PID expected in undetected or unsuccessfully treated infections	0.2	2	8	16	31
NNS to prevent 1 case of gonorrhea	1,085	109	22	11	5
Expected number of false-positive results per 10,000 tests	100	99	95	90	80
Cases of PID prevented by screening	1.3	12	65	129	258
NNS to prevent 1 case of PID	7,751	840	155	78	39

*Assumptions based on data from Gift, 2002.[86] NNS, number needed to screen; PID, pelvic inflammatory disease.

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Purpose	Study design	N	Population/ setting	Demographics	Inc
Bachman, 2003[5]	Evaluate prevalence of chlamydia and gonorrhea in women presented to an urban ED with genitourinary symptoms or pregnancy related complaints and frequency of effective treatment	Cross-sectional interview and urine specimen screen of randomly sampled shifts	403	U.S. urban ED	Women aged 15-35 years; Mean age 23; 81% African American, 44% insured on Medicaid; 33% uninsured; 41% confirmed pregnancy at time of visit. Greater than 50% reported history of STD.	Sexu 15-3 with dysu disch abdc preg
Boyer, 1999[36]	Determine sociodemographic markers and behavioral risk factors associated with STDs in sexually active youth seeking care at a HMO teen clinic	Cross-sectional consecutive sample of racially and ethnically diverse youth	285	U.S. urban HMO teen clinic	Mean age 16.7 years; 58.6% female; 43% African American, 15% white, 14% Latino, 13% Asian	Excl not b used
Cecil, 2001[18]	Characteristics of infection in army recruits	Cross-sectional screening and survey	2,245 (76.5% accepted)	Male army recruits in South Carolina	Mean age 20.6 years (range 17-35); 89% <25 years old; 60% white	All n
Ellen, 1996[37]	Determine whether personal or partner use of crack cocaine is associated with syphilis or gonorrhea and if the relationship is similar for adults and adolescents	Cross-sectional behavioral survey	1,442	Heterosexual males and females attending public STD clinics in 3 cities (Tampa, Philadelphia, San Diego)	Majority African American (72.5% of males and 67% of females)	Past with past partr had uses rece sex, or cr

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Instruments used	Results
Bachman, 2003[5]	Demographic and behavioral questions, LCR testing (LCx, Abbott Lab). Positive was repeated for confirmation	Gonorrhea and chlamydia prevalence 16.4% (62). Associated risk included younger age, A American, greater number of sex partners in last 30 days; antibiotic use in past 4 weeks, d past 30 days; genitourinary symptoms at presentation (vaginal bleeding, dysuria, lower abd pain). Women with an STD were just as likely to have a pelvic exam as women without an significant difference between pelvic exam findings for women with positive test and wome positive test. Women discharged with diagnosis of PID were more likely to test positive for Women with positive tests were not significantly more likely to have received ED based scr women without positive tests.
Boyer, 1999[36]	Self-report questionnaire on sociodemographic risk markers and behavioral factors; endocervical or urethral swab for gonorrhea culture	28.8% reported a history of STD infection; 11.6% of sample had one or more STDs after te Regression analysis indicated that youth who are African American (OR=3.34), had sex pa more years older (OR=2.63), and used marijuana (OR=2.27) were more likely to have STD screening.
Cecil, 2001[18]	Behavioral risk assessment survey and urine specimen tested with LCR	Prevalence of gonorrhea=0.6%, chlamydia=5.3%, co-infection=7.5%. Of those testing posi gonorrhea, 40% reported having symptoms of any kind, and 60% were co-infected with ch Young age was a predictor of both gonorrhea and chlamydia.
Ellen, 1996[37]	Behavioral survey	35% of males and 12.8% of females had gonorrhea. Independent risk factors for gonorrhe sex in last year with a crack cocaine user, failure to use condoms, younger age; for womer age.

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Purpose	Study design	N	Population/ setting	Demographics	Inc
Gunn, 2000[45]	To evaluate a self-administered risk assessment approach that identifies STD clinic patients who are at increased risk of gonorrhea and chlamydia transmission in the subsequent year	Prospective cohort of consecutive patients with one-year follow-up	2,576	STD clinic patients in San Diego	Not provided	Men San
Klausner, 1998[46]	Risk factors for repeat infection with gonorrhea	Case-control comparison among a high risk population	185 (94 cases; 91 controls)	San Francisco City and County control database	Mean age 20 years; 80% African American; 76% with repeated infections had one previous infection (maximum 28)	Case gonc defin 24 y with or in histo diag week of th no k
Liau, 2002[28]	Investigate associations between biologically confirmed marijuana use and laboratory-confirmed STD and condom use	Cross-sectional survey (face-to face and self-administered), urine sample for marijuana screen, self-obtained vaginal swab	522	2 adolescent clinics, 4 public health department clinics, 5 health classes; African American females	Average age 16 years; 81% full-time students; 18% had jobs	Afric year activ

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Instruments used	Results
Gunn, 2000[45]	Risk assessment form: number and types of sex partners, condom use, STD history, and questions about perceived risk. Medical record abstraction for diagnosis. One year after initial enrollment, the medical record was reviewed for evidence of a return visit.	Of the 2,576 enrolled, 204 (7.9%) had a subsequent infection during the 1 year follow-up. N gonococcal urethritis was the most common subsequent diagnosis. Subsequent GC/CT oc (3.1%) including 32 with gonorrhea and 4 with both. MSM as a group had a 5.2% subsequ rate. The strongest predictor of subsequent infection with GC/CT was a recent history of G current visit diagnosis of GC/CT infection. Unsafe sex behaviors had little impact on subse
Klausner, 1998[46]	Patient demographics, health, sexual behavior, and illicit substance use recorded during a private face-to-face interview	Patients with repeated gonorrhea did not differ from patients with first diagnosis in number visits in past 5 years, if they could identify a regular doctor, having a partner with STD, bein health department they had been exposed to an STD, smoking, douching, number of years activity, number of lifetime sex partners, frequency of having a new partner in past 2 month of condom use by any partner type, reporting intoxication by sex partner in past 2 months, money for sex in previous 2 months. Patients with gonorrhea were more likely to be African less likely to be employed or have a high school education, more likely to report a history o infection, and more likely to have received drugs for sex. Regression identified factors asso repeated gonorrhea as more likely to be African American and have a previous history of S infection), less likely to have completed high school.
Liau, 2002[28]	Urine sample for marijuana screen using EMIT® II assay to detect use of marijuana for up to 30 days prior to testing, self-obtained vaginal swab for gonorrhea, and chlamydia testing using LCR assay.	28% of sample screened positive for at least one of 3 STDs; 81.8% reported having sex wi steady partner in the last 6 months; 58.1% reported consistent condom use in past 30 days reported consistent condom use in past 6 months. Lab testing confirmed that 5.4% of adole used marijuana in past 30 days; 41% reported a lifetime history of use of marijuana. Fema marijuana were 3.4 times more likely to test positive for gonorrhea and 3.9 times more like positive for chlamydia. Marijuana use was associated with never using a condom in past 3 (increased risk by 3 times) and in past 6 months (increased risk 3.6 times).

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Purpose	Study design	N	Population/ setting	Demographics	Inc
Marrazzo, 2002[30]	Utility of age and cervical findings in predicting infection with gonorrhea and chlamydia	Retrospective chart review	6,230 new problem visits with pelvic exams	Visits by women to Seattle STD clinics	Not provided	Wom
Mehta, 2001[35]	Prevalence of and risk factors for gonorrhea in patients presenting to the Emergency Department	Cross-sectional; consecutive patients treated at randomized shifts, outcomes included positive gonorrhea and/or chlamydia screen on LCR	2,118 eligible; 981 approached; 700 consented to study (71%)	Male and females aged 18-44 years presenting to urban ED for any medical reason over 2-week period	77% were 18-31 years of age; those enrolled were more likely to be younger, African Americans, and more likely to be treated for STD by ED.	Psyc patie treat confi main
Mertz, 2000[14]	Determine factors associated with acquisition of gonorrhea by men in Newark, NJ	Case-control	214	STD clinics in Newark, comparing 15-29 year old males with culture confirmed gonorrhea to controls with no STD	15-29 year old men	Male gonc

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Instruments used	Results
Marrazzo, 2002[30]	Demographic data in medical records, and results from pelvic exams with gram stain smear of endocervical secretions and quantified polymorphonuclear cells per 1000 using standardized procedures.	133 (2.1%) had gonorrhea detected by culture of cervix. Cervical findings (30 or more PM gram stain, easily induced endocervical bleeding, mucopurulent endocervical discharge) a diagnosis of mucopurulent cervicitis were independently associated with an increased likel infection with either gonorrhea or chlamydia. The stronger association between age and in independent of the presence of any cervical finding. Non-white race was associated with a increase in detection of infection, and 2 or more sex partners in the last 2 months was asso small increase in risk of infection, reporting of a new partner in the same time was not asso infection. The PPV of all cervical findings and of gram stain smear of endocervical secretio cervical infection were significantly higher in women younger than 25 years old than in wom and older. 40% of all women 19 or younger with cervical findings were infected with either chlamydia.
Mehta, 2001[35]	Survey with demographic and behavior questions, urine specimens tested with LCR	13.6% prevalence of gonorrhea and chlamydia, 5.3% with GC alone, in younger age group 1.8% GC/CT in older age group (32-44). The majority of both female and male participants report symptoms. Significant predictors for women included history of STD, new sex partn days, number of sex partners in past 90 days. Significant predictors for men included age < marijuana use in the past 90 days, positive response on the CAGE alcohol screen, new se past 90 days, more than one sex partner in past 90 days, and penile discharge. Regressio having a new sex partner in past 90 days was a significant predictor for women (OR=2.23) <24, having been criticized for drinking, and penile discharge were significant predictors.
Mertz, 2000[14]	Behavioral survey with case and control groups	Cases more likely than controls to be African American, 15-19 years old, or to ever spend a Previous diagnosis of gonorrhea was reported by 41% of cases and 29% of controls. Histo STD was reported by 17% of cases and 25% of controls. 2/3 of both cases and controls ha partner during the month before the clinic visit. Compared with controls, cases with gonorrh frequently reported a least 1 casual sex partner within the preceding month (OR=3.2), sex marijuana during the preceding month (OR=2.4), and a history of incarceration (OR=2.1). H causal sex partner increased risk for gonorrhea infection (OR=3.9).

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Purpose	Study design	N	Population/ setting	Demographics	Inc
Mertz, 2002[15]	Feasibility and acceptability of urine based screening for women entering jail and prevalence of treatment rates	Cross sectional	5,364	Women ages 16-75 years entering 3 urban jails	In all cities the majority of women entering jail were young (< 30 years), and African American	Cons Balti Birm excl
Orr, 2001[11]	To compare rates of subsequent infection with chlamydia, trichomonas, and gonorrhea in a group of high risk adolescents and adults	Prospective cohort; multiple testing of women and men attending clinic for treatment who had previous infection or partner with infection	444	Urban clinic population	70% female; 77% African American; 25% of participants were enrolled as uninfected sexual partner; half of participants attended school and were unemployed	Excl stay or w
Peters, 2000[29]	Association of behaviors and STD risk among adolescents	Descriptive survey	515 with chlamydia results	Adolescent clinics in Georgia	94% African American; mean age 17 (range 13-20); 40% reported symptoms	Fem neec
Shain, 2002[31]	To determine behaviors associated with infections	Follow-up data (6 and 12 months) from an intervention trial	477	Women seen in public health clinics in Texas	70% of sample was <25 years of age (range 14-45); most had low income and low educational level	Cons proje

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Instruments used	Results
Mertz, 2002[15]	Urine specimens transported to university labs in each city and tested using LCR assay for chlamydia and gonorrhea	High prevalence of gonorrhea (8.2%-9.2%) depending on city; highest rates found among y women (<25 years of age), the majority of women were treated in jail or outside (61%-85% limited by length of test result and release of woman from jail; women more likely to be trea were tested at intake.
Orr, 2001[11]	Diagnostic criteria based on culture of endocervical or urethral swabs. Screening on return visit at 1, 3, 5 and 7 months was urine based using PCR	97 (22%) were positive for gonorrhea and 7% were co-infected with gonorrhea and chlamy enrollment, women and African Americans were more likely to be infected. Compared with contacts, adolescents and young adults with an STD were younger, more likely to be enrol reported fewer sex partners in the prior 2 months, and more likely to report use of condom intercourse. No difference between infected and uninfected contacts. Overall 80% (355) h one follow-up visit, compared to those who did not return; returners were younger, female, school, infected at enrollment, reported more sexual partners in prior 2 months. Subsequen were common, irrespective of enrollment status. By 7 months, an estimated 53% of contac with an STD at enrollment had subsequent STD. Regression analysis demonstrated that b and having at least one new sexual partner independently increased likelihood of subsequ
Peters, 2000[29]	Questionnaire on behaviors; cervical PCR test for chlamydia using PCR assay (Roche), gonorrhea was presumptively diagnosed by culture of cervical specimen on Thayer Martin media	76% reported using a condom in past 6 months; 75% of women reported only one partner Prevalence of gonorrhea was 9.9% (43/433), 3.9% tested positive for both gonorrhea and Women with gonorrhea had a lower mean age (16), young women who did not report oral were significantly more likely to have gonorrhea than older women. Consistent condom use associated with lower risk of gonorrhea, but not significantly. Number of sex partners in las was not associated with infections; however, majority of women reported only one sex part months.
Shain, 2002[31]	DNA probe testing of endocervical samples; interview on sexual behaviors (sex with untreated partner, not mutually monogamous, unsafe sex, rapid partner turnover, douches after sex)	Reduction in risk of 5 modifiable factors in study group. The 0-12 month regression model demonstrated that behaviors correctly predicted infection rates in 75.3% of participants. In study group 12% vs. 16.7% control at 0-6 months; 8.8% for study vs. 16.7% at 6-12 month vs. 25.9% at 0-12 months. Unprotected sex with an untreated/incompletely treated partner strongest association with infection (cumulative adjusted OR=5.6, 0-12 months). Mutual mo significantly associated with decreased infection at 6-12 months and 0-12 months. Unsafe use) was significant across all time periods; rapid partner turnover was significantly associa infection at all time points; douching after sex was significantly associated with infection at but not at 6-12 months.

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Purpose	Study design	N	Population/ setting	Demographics	Inc
Todd, 2001[47]	Determine prevalence and correlates of asymptomatic genital tract infection with gonorrhea and chlamydia among ED patients	Cross-sectional screening of consecutive patients presenting for evaluation of non-genitourinary complaints	359 (87% acceptance =312)	ED at urban tertiary care facility in St. Louis, Mo.	56% female, 44% male; 78% African Americans; mean age 23.9 years: 30% unemployed; 36% received public assistance	Age excl to pc disch assa

EVIDENCE TABLE 1. STUDIES OF INDIVIDUAL LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, year	Instruments used	Results
Todd, 2001[47]	Urine sample LCR test performed within 24 hours of collection at hospital lab	Prevalence of asymptomatic gonorrhea and chlamydia was 9.7%; 1% gonorrhea, 0.7% wit gonorrhea and chlamydia, 8.0% with chlamydia, highest prevalence in youngest age grou Correlates of chlamydia infection were younger age, residence in high morbidity zip code, history of gonorrhea and chlamydia, and number of sex partners.

CT, *Chlamydia trachomatis;*
ED, emergency department;
GC, Gonorrhea;
HMO, Health Maintenance Organization;
IV, intravenous;
IVDU, intravenous drug user;
LCR, ligase chain reaction;
PID, pelvic inflammatory disease;
MSM, men who have sex with men;
OR, odds ratio;
PMH/HPF, polymorphonuclear leukocytes per high powered field
PPV, positive predictive value;
SAFE, Sexual Awareness for Everyone;
STD, sexually transmitted disease.

EVIDENCE TABLE 2. STUDIES OF POPULATION LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, Year	Purpose	Study Design	N	Population/ Setting	Demographics	Inclusion/ Exclusion Criteria
Holtgrave, 2003[51]	Determine association between social capital, poverty, income inequality and 4 infectious diseases (including gonorrhea)	State-level correlation analysis	NA	U.S. state level analysis	NA	U.S., state level
Cohen, 2000[52]	Examine the relationship between neighborhood conditions and gonorrhea	Cross sectional block design	55 block groups, population 26,600	City blocks in New Orleans, LA	Average size of block was .04 square miles; average population of 507; 91% African American, 21% unemployed; 34.47% gonorrhea rate	If information was available on the block groups, from the College of Urban and Public Affairs (CUPA) at the University of New Orleans, LA
Becker, 1998[53]	To evaluate the geographic epidemiology of gonorrhea using a GIS (geographic information system) technology	Space-time clustering, data system	7,330 reported cases	Baltimore, MD, 1994 central disease registry	7,330 cases; 3,417 females	NA
Ellen, 1997[50]	Determine whether there are core groups of transmitters of gonorrhea and chlamydia and sociodemographic factors for repeat risk factors	Retrospective analysis of gonorrhea and chlamydia cases	12,506 cases; 9,461 in 5 years	San Francisco, CA	NA	14-35 years of age at initial infection; examined for subsequent infection

EVIDENCE TABLE 2. STUDIES OF POPULATION LEVEL RISK FACTORS IN ADULTS AND ADOLESCENTS

Author, Year	Instruments Used	Results
Holtgrave, 2003[51]	Federal surveillance of STDs from 1999; social capital= community organizational life, involvement in public affairs; volunteerism, informal sociability and social trust, poverty defined by percentage of state population living below poverty line; income inequality.	Social capital was significantly correlated to all outcome measures including GC; poverty was significantly correlated with chlamydia, and income inequality was significantly correlated with chlamydia and AIDS case rates.
Cohen, 2000[52]	Sociodemographic information: age, sex, income level, education, work status; CUPA rated neighborhood deterioration index; sum of annual reported case rates of gonorrhea per 1000 persons for each block group between 1944 and 1996.	Multiple regression analysis included broken window index, poverty, race, unemployment, and marital status. Results showed that the broken window index was the only variable that remained significantly related to gonorrhea rates (p=0.005).
Becker, 1998[53]	Reported cases of gonorrhea from STD clinic and non-STD clinic sources following CDC reporting guidelines; medical records with addresses and other demographic information.	7,330 cases of gonorrhea were reported by Baltimore, MD (city) residents in 1994; 6,410 (87%) of the cases were aged 15-39 yrs. When ethnicity was reported, 97% were African American. Consensus tracks were created for core cases, as well as adjacent areas.
Ellen, 1997[50]	Sociodemographic information: age, sex, provider, date of visit, address for initial visit and date of visit for repeat visit.	During 5 years, 8,613 recurrent cases of gonorrhea among males (17%) and 3,893 among females (19%) were identified. Geographically defined populations were at increased risk for repeat infection with gonorrhea in San Francisco, CA, independent of race and ethnicity, with likely core transmitters per region of the city.

CDC, Centers for Disease Control and Prevention;
CT, *Chlamydia trachomatis*;
ED, emergency department;
GC, gonorrhea;
IVDU, intravenous drug user;
MSM, men who have sex with men;
PID, pelvic inflammatory disease;
PPV, positive predictive value;
STD, sexually transmitted disease.

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	N	Study Test/Specimen	Gold Standard/ Expanded Gold Standard	Discrepant/Confirm
Bassiri, 1997[69]	3,340 women	PCR (Amplicor® CT/NG) Urine	None	Positive samples retes PCR assay and 16S R PCR.
Beltrami, 1998[71]	640 men	DNA probe (PACE® 2) Urethral swabs	Culture Plated to Thayer-Martin agar; typical appearing colonies were identified presumptively by gram stain and the oxidase reaction; final identification was performed by carbohydrate utilization.	None
Chan, 2000[72]	825 men 399 women	1. SDA (BDProbeTec™ ET) 2. PCR (Amplicor) Urine	None	In-house PCR assays
Cosentino, 2003[65]	455 women	SDA (BDProbeTec™ ET) Vaginal and cervical swabs; study compares specimen sites	Culture plated to modified Thayer Martin medium and chocolate agar; identification was based on gram staining, oxidase test, and Gonochek II.	Samples with discrepa (SDA/culture) were eva LCR. Samples were co positive if they were po culture or by two molec (SDA and LCR).

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Population/Setting	Results	Limitati
Bassiri, 1997[69]	Asymptomatic women aged 15-44 years attending 24 family planning centers or gynecology clinics in 14 European countries for contraceptive advice (n=2,987) or pregnancy termination (n=353).	Of 3,340 samples tested, 9 (0.3%) were positive for *N. gonorrhoeae;* all were confirmed positive by repeat testing using the same assay; all 9 were negative using 16S RNA-based PCR.	Prevalence w low to adequ determine tes performance standard.
Beltrami, 1998[71]	Asymptomatic arrestees in New Orleans, LA (1993-1994).	DNA probe was positive in 9 samples (2%), culture in 13 (3%). Sensitivity=54%, specificity=99.5%, PPV=78%, NPV=99%. Sensitivity and PPV for detection of gonorrhea were lower than those found in other studies, but this study included only asymptomatic men.	Arrestees do represent pri care screenir population; n resolution of discrepant re
Chan, 2000[72]	Symptom status not known; consecutive patients attending 3 STD clinics and other family physicians' offices in Saskatchewan, Canada.	Women PCR: sensitivity=100%, specificity=98.4%, PPV=50%, NPV=100% SDA: sensitivity=100%, specificity=99.2%, PPV=66.7%, NPV=100% Men PCR: sensitivity=96.2%, specificity=99.1%, PPV=78.1%, NPV=99.9% SDA: sensitivity=100%, specificity=99.9%, PPV=96.3%, NPV=100% Throughput: 46 speciments/8 hours for PCR and 150/8 hours with SDA.	Predominant clinic populat unknown syn status.
Cosentino, 2003[65]	Symptomatic women attending reproductive health clinics in Pittsburgh, PA (1997-2000).	Culture (cervix): sensitivity=76.9%, specificity=100%, PPV=100%, NPV=97.9% SDA (vagina): sensitivity=100%, specificity=99.8%, PPV=97.5%, NPV=100% SDA (cervix): sensitivity=100%, specificity=100%, PPV=100%, NPV=100%	Women were symptomatic

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Quality Rating
Bassiri, 1997[69]	Poor
Beltrami, 1998[71]	Poor
Chan, 2000[72]	Fair
Cosentino, 2003[65]	Fair

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	N	Study Test/Specimen	Gold Standard/ Expanded Gold Standard	Discrepant/Confirn
Crotchfelt, 1997[70]	344 men 192 women	PCR (Amplicor® CT/NG) Women: endocervical swabs and urine Men: urethral swabs and urine	Culture plated to modified Thayer Martin medium; colonies containing oxidase-positive and gram-negative diplococci were presumptively identified as *N. gonorrhoeae,* confirmed by using fluorescent-antibody staining.	For specimens that we positive and culture ne was repeated using a (16S rRNA PCR assay.
Darwin, 2002[75]	669 women	DNA probe (Hybrid Capture® 2) Endocervical swab (culture) Endocervical brush (DNA probe)	Culture plated to modified Thayer Martin medium; oxidase-positive, gram-negative culture colonies were confirmed using fluorescein-conjugated antibodies specific for *N. gonorrhoeae.*	Discrepant results betv probe and culture were by direct fluorescent-a
Darwin, 2002[58]	1,202 men	All subjects were tested with DNA probe (PACE® 2C), then 140 positives were tested with 2 additional DNA probes (Hybrid Capture® 2 and PACE® 2). Urethral swab	None	PCR (SHARP assay)
Diemert, 2002[59]	9,834 men and women	PCR (Cobas Amplicor® CT/NG) Women: endocervical swabs and urine Men: urethral swabs and urine	737 also tested by culture plated to modified Thayer Martin and chocolate agar. Identities of presumptive isolates were confirmed by carbohydrate utilization profiles.	Specimens positive by underwent testing by 1 based PCR.

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Population/Setting	Results	Limitati
Crotchfelt, 1997[70]	Symptom status not known; men and women attending two Baltimore, MD (city) STD clinics (1995).	Men: PCR (urine): sensitivity=94.4%, specificity=98.5% PCR (urethra): sensitivity=97.3%, specificity=97.0% Culture: sensitivity=76.6%, specificity=100% Women: PCR (urine): sensitivity=90.0%, specificity=95.9% PCR (cervix): sensitivity=100%, specificity=99.4% Culture: sensitivity=65.2%, specificity=100%	STD clinic population; u symptom sta
Darwin, 2002[75]	High-risk women attending public STD clinics in Birmingham, AL and Baltimore, MD.	DNA probe vs. culture: sensitivity=90.3% (81.0-96.0), specificity=96.8%, PPV=77.4%, NPV=98.8% DNA probe vs. adjudicated: sensitivity=92.2% (84.6-96.8), specificity=99.8%, PPV=98.8%, NPV=98.8% Culture vs. adjudicated: sensitivity=80.0% (70.3-87.7), specificity=100%, PPV=100%, NPV=97.0%	STD clinic population; u symptom sta
Darwin, 2002[58]	Symptomatic and asymptomatic men from a number of STD clinics.	PACE 2 and Hybrid Capture 2 tests had positive and negative agreements of 98.3% and 99.8% respectively. Hybrid Capture 2: sensitivity=98.9%, specificity=99.9%, PPV=99.4%, NPV=99.8% PACE 2: sensitivity=99.4%, specificity=99.9%, PPV=99.4, NPV=99.9%	Results reflec second step testing proce clinic populat unknown syn status.
Diemert, 2002[59]	Symptomatic and asymptomatic consecutive patients undergoing evaluation for *N. gonorrhoeae* infection at outpatient clinics affiliated with a large Montreal tertiary-care center and 2 health centers in northern Quebec serving a primarily native Canadian population (1999-2000).	PCR vs. culture: sensitivity=100%, specificity=99.9% (99.2-100).	Prevalence w low to adequ determine tes performance unknown syn status; data r provided by s

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Quality Rating
Crotchfelt, 1997[70]	Fair
Darwin, 2002[75]	Fair
Darwin, 2002[58]	Poor
Diemert, 2002[59]	Poor

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	N	Study Test/Specimen	Gold Standard/ Expanded Gold Standard	Discrepant/Confirn
Farrell, 2001[61]	260 men and women	1. PCR (Cobas Amplicor® CT/NG) 2. LCR (LCx NG) 3. PCR (In-house cppB gene) Urine	Infected=at least 2 positive tests. Not infected=at least 2 negative tests.	Retested at least twice methods.
Gaydos, 2003[78]	1,484 women	TMA (Combo 2 assay) Urine Endocervical swab	Swabs: LCR, culture Urine: LCR Infected=culture positive or LCR swab positive + urine specimen positive. Not infected=both culture and LCR on both specimens types negative.	TMA positive specimer patients classified as n underwent masked tes with a subset of negati by confirmatory TMA a
Leslie, 2003[55]	4,324 men and women (PCR) 2,305 men and women (culture)	PCR (Amplicor® CT/NG) FDA-listed sites: penile/urethral swabs urine cervical/vaginal swabs Non FDA-listed sites: ano-rectal oropharyngeal other	Culture plated to New York City agar and chocolate or horse-blood agar (depending on site).	16S rRNA assay used 2001; then cppB PCR following discontinuatio rRNA.

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Population/Setting	Results	Limitatio
Farrell, 2001[61]	Asymptomatic patients from widespread geographical sites in Queensland, Australia included populations known to have a high prevalence of asymptomatic *N. gonorrhoeae* and high PCR false-positivity.	PCR: sensitivity=97.9%, specificity=93.9%, PPV=78.0%, NPV=99.5% LCR: sensitivity=95.7%, specificity=100%, PPV=100%, NPV=99.1% In-house PCR: sensitivity=97.9%, specificity= 100%, PPV=100%, NPV=99.5%	Data not prov sex.
Gaydos, 2003[78]	Symptomatic and asymptomatic 18-35 year old women from 7 geographically diverse STD, family planning, and OB/GYN clinics with wide prevalence rates of *N. gonorrhoeae.*	Asymptomatic: Swab: sensitivity=96.9% (83.8-99.9), specificity=99.6% (98.7-100), PPV=93.9%, NPV=99.8% Urine: sensitivity=87.5% (71.0-96.5), specificity=99.5% (98.5-99.1), PPV=90.3%, NPV=99.3%. Symptomatic: Swab: sensitivity=100% (96.2-100), specificity=98.1% (96.9-98.9), PPV=86.2%, NPV=100% Urine: sensitivity=92.6% (85.3-97.0), specificity=99.1% (98.2-99.6), PPV=92.6%, NPV=99.1%. For 34 pregnant women, TMA results were concordant with patient infected status in all specimens (100% sensitivity and 100% specificity).	
Leslie, 2003[55]	Tests performed in a tertiary referral public health laboratory; specimens referred from Victoria, Australia. Patients were predominantly men with high rates of STDs.	PCR overall: sensitivity=81.7%, specificity=99.5%, PPV=92.7%, NPV=98.5%. PCR for FDA-listed specimens (553 penile/urethral swabs, urine, and cervical/vaginal swabs): sensitivity=96.7%, specificity=99.8%, PPV=98.9%, NPV=99.4%. PCR for non FDA-listed specimens (827 ano-rectal, oropharyngeal and other specimen types): sensitivity=65.1%, specificity=99.4%, PPV=84.8%, NPV=98.1%. No significant difference between the 2 confirmatory assays (p=0.65).	STD clinic population; u symptom stat sensitivity/sp data not prov sex or specifi specimen.

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Quality Rating
Farrell, 2001[61]	Fair
Gaydos, 2003[78]	Good
Leslie, 2003[55]	Fair

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	N	Study Test/Specimen	Gold Standard/ Expanded Gold Standard	Discrepant/Confirm
Livengood, 2001[57]	618 women	PCR (Cobas Amplicor® CT/NG) Endocervical swabs	Culture plated to Jembec media; gram-negative, oxidase-positive, and Gonogen II-positive results were reported as a positive culture. Infected=culture positive or 2 or more other tests positive.	PCR assay was repeat another laboratory in a LCR.
Martin, 2000[76]	2,192 women 1,981 men	1. PCR (Amplicor® CT/NG) 2. PCR (Cobas Amplicor® CT/NG) Women: endocervical swabs and urine Men: urethral swabs and urine	Culture; gram-negative diplococci were confirmed as *N. gonorrhoeae* by glucose utilization profiles.	16S rRNA PCR
Modarress, 1999[63]	1,727 women 19 men	1. DNA probe (Hybrid Capture® 2) 2. DNA probe (PACE® 2) Women: endocervical brush Men: urethral swab	Infected=2 of 3 tests positive.	PCR

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Population/Setting	Results	Limitati
Livengood, 2001[57]	Women undergoing testing for endocervical *N. gonorrhoeae* infection, as determined by their practitioners, in the emergency department, private and staff OB/GYN clinics, and inpatient units of Duke University Medical Center, Durham, NC.	Samples were negative for 591, positive for 24, and discrepant for 3. After discrepancy resolution, 591 true negatives and 27 true positives. PCR: sensitivity=96.3%, specificity=100%, PPV=100%, NPV=99.8% Culture: sensitivity=92.6%, specificity=100%, PPV=100%, NPV=99.7%	Unknown syr status.
Martin, 2000[76]	Symptomatic and asymptomatic consecutive patients seen in STD clinics and family-planning centers in multiple U.S. cities.	The 2 PCR assays were 98.8% concordant and exhibited identical performance characteristics. Results for PCR (Cobas Amplicor): All women (145 cases; results similar if symptoms or not) Endocervical: sensitivity=92.4%, specificity=99.5% Urine: sensitivity=64.8%, specificity=99.8% Asymptomatic men (26 cases) Urethral: sensitivity=73.1%, specificity=99.0% Urine: sensitivity=42.3%, specificity=99.9% Symptomatic men (372 cases) Urethral: sensitivity=98.1%, specificity=98.8% Urine: sensitivity=94.1%, specificity=99.9% Sensitivity of culture Women: asymptomatic=86.2%, symptomatic=83.9% Men: asymptomatic=46.2%; symptomatic=92.7	Some subjec STD clinics.
Modarress, 1999[63]	Symptom status unknown for patients attending STD, family planning, and private practice clinics in U.S.	99.6% initial agreement between the two methods; 9 were discrepant. Hybrid Capture® 2: sensitivity=100%, specificity=99.7% PACE® 2: sensitivity=87.1%, specificity=100%	Some of subj from STD clir few men to re results by se

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Quality Rating
Livengood, 2001[57]	Fair
Martin, 2000[76]	Good
Modarress, 1999[63]	Fair

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	N	Study Test/Specimen	Gold Standard/ Expanded Gold Standard	Discrepant/Confirm
Moncada, 2004[77]	1,569 women	1. TMA (APTIMA™ Combo 2) 2. LCR (LCx) Urine (used as part of specimen standard) Endocervical swabs (used as single specimen diagnosis)	Culture plated to Thayer Martin media; oxidase-positive colonies yielding gram-negative diplococci were subcultured to chocolate agar plates. Isolates were confirmed as *N. gonorrhoeae* by either sugar utilization tests, fluorescent antibody, or Haemophilus-Neisseria identification (HNID). Infected=culture positive or both LCR and TMA positive.	Another TMA assay
Palladino, 1999[62]	73 men	PCR (Amplicor® CT/NG) Urethral swabs Urine	Culture plated to heated blood agar and modified Thayer Martin agar and confirmed by morphology, gram-stain, positive oxidase test, lack of growth on nutrient agar, and positive Gonocheck II test.	In-house PCR assay, i additional confirmation alternative PCR assay rRNA PCR testing was specimens positive by PCR, but negative for
Roymans, 1999[68]	358 women 71 men	1. PCR (In house) 2. DNA probe (PACE® 2) Cervical or urethral swabs	None	Retesting by PCR and then with another PCR
Schachter, 1999[64]	1370 women	DNA probe (Hybrid Capture® 2 CT/GC) Cervical brush (nonpregnant women) or swab (pregnant women)	Culture plated to Thayer Martin media. Oxidase-positive gram-negative diplococci were confirmed as gonococci by using sugar utilization tests, except at one site where Gonochek-II was used.	PCR if negative culture DNA probe
Schwebke, 1996[73]	453 women 546 men	DNA probe (PACE® 2) Women: endocervical swab Men: urethral swab	Culture plated to modified Thayer Martin agar. Presence of *N. gonorrhoeae* was determined by presumptive identification using growth on Thayer Martin agar, gram stain morphology, and positive oxidase reaction.	Gram stain

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Population/Setting	Results	Limitati
Moncada, 2004[77]	Symptomatic and asymptomatic 18-35 year old women from 7 geographically diverse STD, family planning, and OB/GYN clinics with wide prevalence rates of *N. gonorrhoeae.*	Endocervical swab: TMA: sensitivity=99.2%, specificity=98.6% LCR: sensitivity=96.1%, specificity=99.7% Culture: sensitivity=85.9%, specificity=100%	Examined differences ir specimen vs patient stand performance for endocervi swab only; ur symptom sta
Palladino, 1999[62]	Men in Western Australia seeking medical attention for STDs or sexual partners of confirmed cases.	Urine PCR: sensitivity=100%, specificity=100%, PPV=100%, NPV=100% Urethral culture: sensitivity=86.8%, specificity=100%, PPV=100%, NPV=87.5%	High risk pop small sample unknown syn status; quest generalizabil
Roymans, 1999[68]	Symptom status not known, patients visiting OB/GYN and dermatology clinics of 5 hospitals in the Netherlands.	PCR: sensitivity=100%, specificity=99.5% DNA probe: sensitivity=61.5%, specificity=100%	Low prevaler symptoms nc known; resul given by sex.
Schachter, 1999[64]	Symptom status not known for women seen in STD or family planning clinics at several U.S. sites.	For cervical brush: of 218 positive by the initial test, 106 were positive by the confirmation test. DNA probe: sensitivity=92.6%, specificity=98.5% Results similar for swab specimens (data not provided).	Unknown syr status.
Schwebke, 1996[73]	Symptom status not known for patients seen at 5 public STD clinics in Chicago, IL.	Disparate results occurred among 55 specimens. Using culture as gold standard, there were 31 false-positive and 24 false-negative DNA probe assays. DNA probe after discrepancy resolution Urethral: sensitivity=91.7%, specificity=96.4% Endocervical: sensitivity=86.2%, specificity=96.8%	Some subjec STD clinics; g stain used to discrepancie

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Quality Rating
Moncada, 2004[77]	Fair
Palladino, 1999[62]	Poor
Roymans, 1999[68]	Fair
Schachter, 1999[64]	Fair
Schwebke, 1996[73]	Poor

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	N	Study Test/Specimen	Gold Standard/ Expanded Gold Standard	Discrepant/Confirm
Tabrizi, 2004[54]	174 women	PCR (Cobas Amplicor® CT/NG) Stored patient samples: 99 tampons 14 urine 4 urethral swabs 7 cervical swabs	Consensus results: positivity defined as any sample positive by at least 2 out of the 4 methods used besides PCR (Cobas Amplicor® CT/NG) (MB, FRET, 16S rRNA, or LCx).	In-house developed P(confirmatory assays (L using MB and FRET p rRNA, and LCR.
Uhrin, 1997[66]	199 women	PCR Endocervical swab	Culture plated to JEMBEC agar.	Not described (referen
Van der Pol, 2001[56]	2,109 men and women	1. SDA (BD ProbeTec™ ET) 2. LCR Women: endocervical swabs and urine Men: urethral swabs and urine	Culture plated to modified Thayer Martin agar or Martin Lewis media; gram-negative, oxidase-positive specimens were confirmed using a biochemical method and at least one other method (fluorescent antibody staining, Gonogen, or GenProbe direct probe). Infected=culture positive or LCR swab and urine positive (women); culture positive or LCR urine positive (men).	None
Van Doornum, 2001[60]	1,001 503 women 498 men	1. LCR (LCx Probe) 2. PCR (Cobas Amplicor® CT/NG) Women: endocervical swabs and urine Men: urethral swabs and urine	Culture plated to GC-lect for Gram staining and oxidase testing. Infected=3 of 4 tests positive, 2 swabs positive, or 2 urine specimens positive.	Discrepant results were discrepant samples tha solitary and repeatedly only one assay were fu by 16s analysis.

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Population/Setting	Results	Limitatio
Tabrizi, 2004[54]	122 positive samples (by PCR Cobas Amplicor® CT/NG) were selected from stored samples of >3000 women who had participated in studies in Australia and Pacific islands; 50 negative samples also randomly selected.	Using the consensus algorithm, 73/122 (59.8%) were confirmed positive; sensitivity and specificity were not reported.	Symptom sta known; no sensitivity/sp data.
Uhrin, 1997[66]	Symptom status not known; women patients seen in public clinics in Pittsburgh, PA.	Culture: sensitivity 28.6%, specificity 100% PCR: sensitivity 100%, specificity 100%	Discrepant te not described symptoms no known.
Van der Pol, 2001[56]	Symptomatic and asymptomatic patients attending STD, family planning and OB/GYN clinics at several U.S. sites.	SDA among asymptomatic patients: Endocervical swab: sensitivity=97.4%, specificity=99.6% Urine (women): sensitivity=86.5%, specificity=99.3% Urethral swab: sensitivity=100%, specificity=99.5% Urine (men): sensitivity=100%, specificity=100% SDA among symptomatic patients: Endocervical swab: sensitivity=96.1%, specificity=99.3% Urine (women): sensitivity=83.7%, specificity=99.6% Urethral swab: sensitivity=98.4%, specificity=94.8% Urine (men): sensitivity=97.9%, specificity=94.4%	STD populati included.
Van Doornum, 2001[60]	Visitors of an STD clinic in Amsterdam in 1998; < 30 years of age.	Significant differences in PCR performances for female swab and urine specimens (p<0.05). PCR Female swab: sensitivity=100%, specificity=97.4%, PPV=31.6%, NPV=100% Female urine: sensitivity=66.7%, specificity=98.6%, PPV=36.4%, NPV=99.6% Male swab: sensitivity=100%, specificity=99.2%, PPV=84.0%, NPV=100% Male urine: sensitivity=95.2%, specificity=99.4%, PPV=87.0%, NPV=99.8%	STD populati unknown sym status.

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Quality Rating
Tabrizi, 2004[54]	Poor
Uhrin, 1997[66]	Poor
Van der Pol, 2001[56]	Good
Van Doornum, 2001[60]	Fair

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	N	Study Test/Specimen	Gold Standard/ Expanded Gold Standard	Discrepant/Confirm
Whiley, 2002[74]	152 specimens	PCR (LightCycler real-time assay using FRET) vs. in-house PCR (ELAHA based) Urine	Not reported	Not reported
Young, 1997[67]	161 homosexual men	DNA probe (PACE® 2) Pharyngeal and rectal swabs	Culture plated to modified New York City medium; suspect culture colonies were tested by the oxidase test: oxidase-positive Gram-negative diplococci were confirmed as *N. gonorrhoeae* by immunological and biochemical tests.	Discrepant results wer PACE 2 using the origi and repeated reactive from culture negative p tested by the Gen-PC/

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Population/Setting	Results	Limitati
Whiley, 2002[74]	Specimens submitted to the Queensland health Pathology Service.	*N. gonorrhoeae* was detected in 29 (19%) specimens by LightCycler PCR and in 31 (20%) specimens by in-house PCR. Negative results were obtained from 121 (80%) by both assays; clinical sensitivity for LightCycler PCR was 94%.	No informatic population, g standard, or discrepant te
Young, 1997[67]	Homosexual men attending the Dept. of Genitourinary Medicine, Edinburgh Royal Infirmary (1995-1996).	DNA probe (PACE® 2) after resolution of discrepant results Rectal: sensitivity=94.1%, specificity=100%, PPV=100%, NPV=99.3% Pharyngeal: sensitivity=86.4%, specificity=100%, PPV=100%, NPV=97.9% Culture Rectal: sensitivity=88.2%, NPV=98.6% Pharyngeal: sensitivity=59.0%, NPV=93.9% Overall agreement between rectal culture and Gen-Probe was 97.5% with 3/4 discrepancies due to negative cultures. Overall agreement between pharyngeal culture and Gen-Probe was 91.3% with 10/14 discrepancies due to negative cultures. Gen-Probe was significantly more sensitive than throat culture ($p<0.05$) but not rectal culture ($p>0.2$).	Unknown syr status.

CT/NG, Chlamydia trachomatis N. gonorrhoeae; ELAHA, enzyme-linked amplicon hybridization assay; FDA, U.S. Food and Drug Administration; FRET, fluorescence resonance energy transfer; LCR, ligase chain reaction; NPV, negative predictive value; OB/GYN, obstetrics and gynecology; PCR, polymerase chain reaction; PPV, positive predictive value; SDA, strand displacement amplification; STD, sexually transmitted disease; TMA, transcription mediated amplification.

EVIDENCE TABLE 3. STUDIES OF GONORRHEA SCREENING TESTS

Author, Year	Quality Rating
Whiley, 2002[74]	Poor
Young, 1997[67]	Fair

APPENDIX 1. SCREENING FOR GONORRHEA: UPDATE OF THE EVIDENCE, SEARCH STRATEGIES

Database: MEDLINE® (1966-July 2004)

Screening

1. exp GONORRHEA/
2. exp Neisseria gonorrhoeae/
3. 1 or 2
4. exp Mass Screening/
5. 3 and 4
6. limit 5 to (all adult <19 plus years> or adolescent <13 to 18 years>)
7. from 6 keep 1-138

Risk Factors

1. exp GONORRHEA/
2. exp Neisseria gonorrhoeae/
3. 1 or 2
4. exp RISK REDUCTION BEHAVIOR/ or exp RISK/ or RISK-TAKING/ or exp RISK MANAGEMENT/
5. 3 and 4
6. limit 5 to (all adult <19 plus years> or adolescent <13 to 18 years>)
7. from 6 keep 1-341

Screening Tests

1. exp GONORRHEA/
2. exp Neisseria gonorrhoeae/
3. 1 or 2
4. exp Mass Screening/is, ma, mt, st [Instrumentation, Manpower, Methods, Standards]
5. 3 and 4
6. from 5 keep 1-54

Test Performance

1. exp GONORRHEA/
2. exp Neisseria gonorrhoeae/
3. 1 or 2
4. exp "Sensitivity and Specificity"/
5. exp Diagnostic Errors/
6. 4 or 5
7. 3 and 6
8. from 7 keep 1-304

Cost

1. exp GONORRHEA/
2. exp Neisseria gonorrhoeae/
3. 1 or 2
4. exp "Costs and Cost Analysis"/
5. 3 and 4

APPENDIX 1. SEARCH STRATEGIES (continued)

6. exp GONORRHEA/ec [Economics]
7. 5 or 6 from 7 keep 1-117

Pregnancy – Maternal Outcomes (1966 – July 2004)

1. exp GONORRHEA/
2. exp NEISSERIA GONORRHOEAE/
3. gonorrh$.mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
4. 1 or 2 or 3
5. exp mass screening/ or screen$.mp.
6. 4 and 5
7. exp GONORRHEA/di
8. 6 or 7
9. exp PREGNANCY/ or exp PREGNANCY COMPLICATIONS/
10. (septic$ adj3 abort$).mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
11. exp Fetal Death/
12. (stillborn or stillbirth$).mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
13. (preterm$ or prematur$).mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
14. exp Infant, Low Birth Weight/
    (low adj3 birth weight$).mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
15. ((low or lower$ or reduc$) adj3 (weight$ or birthweight$)).mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
16. chorioamnionit$.mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
17. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
18. 8 and 18
19. limit 19 to English language
20. 19 not 20
21. limit 21 to abstracts
22. 20 or 22
23. from 23 keep 1-279

Pregnancy – Neonatal Outcomes

1 exp GONORRHEA/
2 exp NEISSERIA GONORRHOEAE/
3 gonorrh$.mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
4 or 2 or 3
5 exp mass screening/ or screen$.mp.
6 4 and 5
7 exp GONORRHEA/di
8 6 or 7

APPENDIX 1. SEARCH STRATEGIES (continued)

9 neonat$.mp. or exp Infant, Newborn/
10 8 and 9
11 maternal fetal transmission.mp. or exp Disease Transmission, Vertical/
12 exp GONORRHEA/tm [Transmission]
13 4 and 11
14 9 and 12
15 13 or 14
16 limit 15 to human
17 10 or 16
18 limit 17 to english language
19 117 not 18
20 limit 19 to abstracts
21 18 or 20
22 from 21 keep 1-199

Pregnancy - Cost

1 exp GONORRHEA/
2 exp NEISSERIA GONORRHOEAE/
3 gonorrh$.mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
4 1 or 2 or 3
5 exp mass screening/ or screen$.mp.
6 4 and 5
7 exp GONORRHEA/di
8 6 or 7
9 exp "Costs and Cost Analysis"/
10 ec.fs.
11 9 or 10
12 8 and 11 from 12 keep 1-78

Neonatal Chemoprophylaxis

1 Ophthalmia Neonatorum/
2 (ae or po or to).fs.
3 1 and 2
4 (injur$ or harm$ or damag$).mp. [mp=title, original title, abstract, name of substance, mesh subject heading]
5 1 and 4
6 advers$.mp.
7 1 and 6
8 exp GONORRHEA/
9 exp NEISSERIA GONORRHOEAE/
10 8 or 9
11 exp CONJUNCTIVITIS/ci, pc, ep, et [Chemically Induced, Prevention & Control, Epidemiology, Etiology]
12 exp BLINDNESS/ci, pc, ep, et [Chemically Induced, Prevention & Control, Epidemiology, Etiology]

APPENDIX 1. SEARCH STRATEGIES (continued)

13 11 or 12
14 10 and 13
15 14 and (2 or 4 or 6)
16 3 or 5 or 7 or 15
17 from 16 keep 1-47

APPENDIX 2. USPSTF QUALITY RATING CRITERIA[44]

Diagnostic Accuracy Studies

Criteria

- Screening test relevant, available for primary care, adequately described.
- Study uses a credible reference standard, performed regardless of test results.
- Reference standard interpreted independently of screening test.
- Handles indeterminate results in a reasonable manner.
- Spectrum of patients included in study.
- Sample size.
- Administration of reliable screening test.

Definition of Ratings Based On Above Criteria

Good: Evaluates relevant available screening test; uses a credible reference standard; interprets reference standard independently of screening test; reliability of test assessed; has few or handles indeterminate results in a reasonable manner; includes large number (more than 100) broad-spectrum patients with and without disease.

Fair: Evaluates relevant available screening test; uses reasonable although not best standard; interprets reference standard independent of screening test; moderate sample size (50 to 100 subjects) and a "medium" spectrum of patients.

Poor: Has important limitation such as: uses inappropriate reference standard; screening test improperly administered; biased ascertainment of reference standard; very small sample size of very narrow selected spectrum of patients.

Randomized Controlled Trials (RCTs) and Cohort Studies

Criteria

- Initial assembly of comparable groups**:** RCTs—adequate randomization, including concealment and whether potential confounders were distributed equally among groups; cohort studies—consideration of potential confounders with either restriction or measurement for adjustment in the analysis; consideration of inception cohorts.
- Maintenance of comparable groups (includes attrition, cross-overs, adherence, contamination).
- Important differential loss to follow-up or overall high loss to follow-up.
- Measurements: equal, reliable, and valid (includes masking of outcome assessment).
- Clear definition of interventions.
- Important outcomes considered.
- Analysis: adjustment for potential confounders for cohort studies, or intension-to-treat analysis for RCTs.

APPENDIX 2. QUALITY RATING CRITERIA (continued)

Definition of Ratings Based On Above Criteria

Good: Meets all criteria: Comparable groups are assembled initially and maintained throughout the study (follow-up at least 80 percent); reliable and valid measurement instruments are used and applied equally to the groups; interventions are spelled out clearly; important outcomes are considered; and appropriate attention to confounders in analysis.

Fair: Studies will be graded "fair" if any or all of the following problems occur, without the important limitations noted in the "poor" category below: Generally comparable groups are assembled initially but some question remains whether some (although not major) differences occurred in follow-up; measurement instruments are acceptable (although not the best) and generally applied equally; some but not all important outcomes are considered; and some but not all potential confounders are accounted for.

Poor: Studies will be graded "poor" if any of the following major limitations exists: Groups assembled initially are not close to being comparable or maintained throughout the study; unreliable or invalid measurement instruments are used or not applied at all equally among groups (including not masking outcome assessment); and key confounders are given little or no attention.

Case Control Studies

Criteria

- Accurate ascertainment of cases.
- Nonbiased selection of cases/controls with exclusion criteria applied equally to both.
- Response rate.
- Diagnostic testing procedures applied equally to each group.
- Measurement of exposure accurate and applied equally to each group.
- Appropriate attention to potential confounding variable.

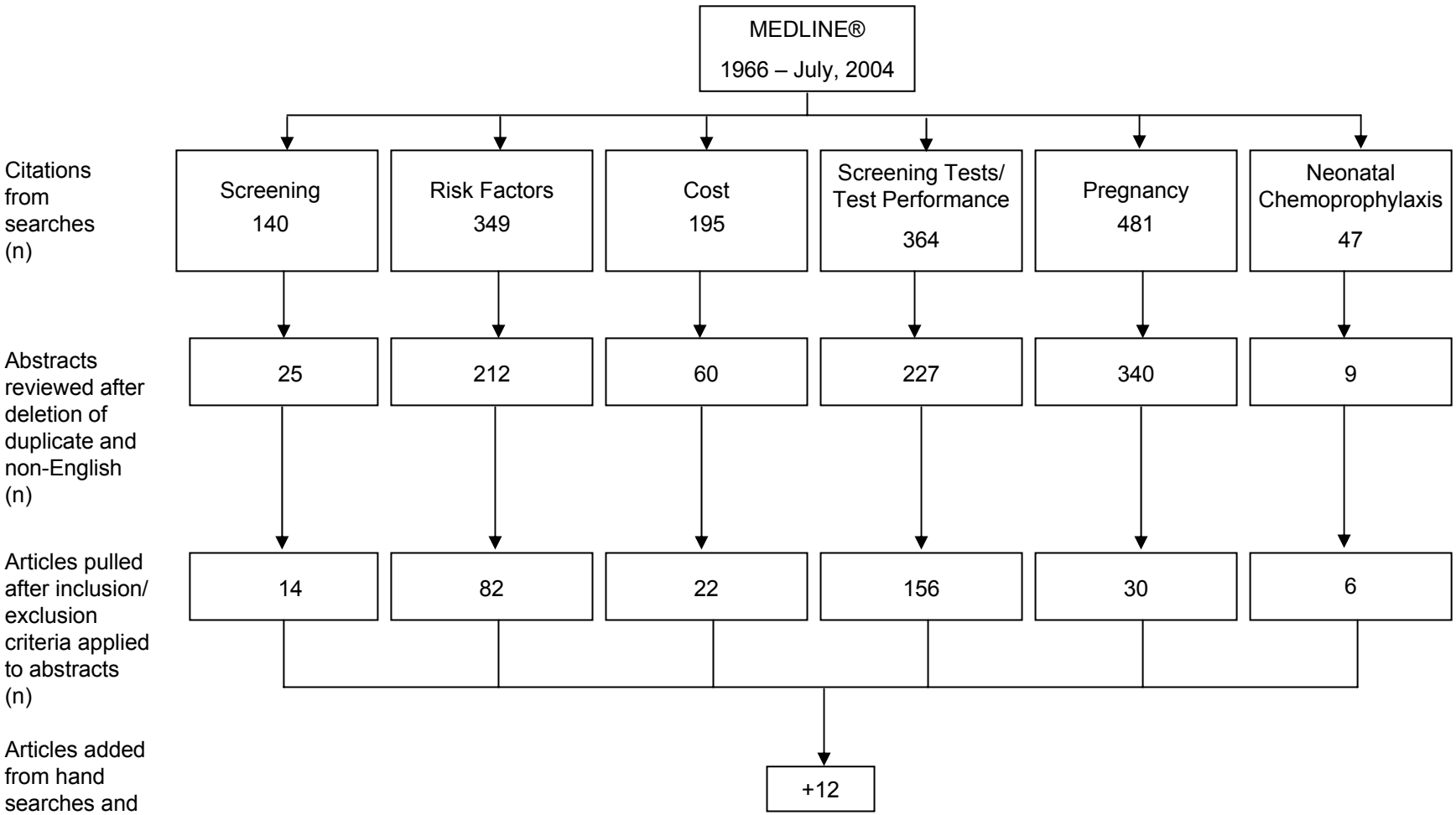
Definition of Ratings Based On Above Criteria

Good: Appropriate ascertainment of cases and nonbiased selection of case and control participants; exclusion criteria applied equally to cases and controls; response rate equal to or greater than 80 percent; diagnostic procedures and measurements accurate and applied equally to cases and controls; and appropriate attention to confounding variables.

Fair: Recent, relevant, without major apparent selection or diagnostic work-up bias but with response rate less than 80 percent or attention to some but not all important confounding variables.

Poor: Major selection or diagnostic work-up biases, response rates less than 50 percent, or inattention to confounding variables.

APPENDIX 3. SCREENING FOR GONORRHEA: UPDATE OF THE EVIDENCE, SEARCH RESULTS



APPENDIX 4. SCREENING FOR GONORRHEA: UPDATE OF THE EVIDENCE, REVIEWERS

Content Experts	William L. H. Whittington, PhD Research Scientist Medicine, Allergy & Infectious Diseases University of Washington
	Hunter Handsfield, MD Harborview Medical Center
	M. Kim Oh, MD Department of Pediatrics University of Alabama, Birmingham
	Barbara Van der Pol, MD Indiana University - Purdue University Indianapolis Infectious Diseases
	Charles H. Livengood III, MD Duke Hospital
	Jeffrey Peipert, MD, MPH Women & Infants' Hospital
	Colin Jordan, MD Oregon Health & Science University Infectious Diseases
Federal Agencies	Bob Johnson, MD CDC
	Stuart M. Berman, MD, ScM CDC
	David Meyers, MD AHRQ
	Linda Kinsinger, MD, MPH VA National Center for Health Promotion and Disease Prevention
	Roxanne Shively FDA, HHS
USPSTF Members	Jonathan D. Klein, MD, MPH
	Kimberly D. Gregory, MD, MPH