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Systematic Review of Diagnostic Tests for Vaginal Trichomoniasis

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ABSTRACT

Objective: To review critically and to summarize the evidence of diagnostic tests and culture media for the diagnosis of *Trichomonas* vaginitis.

Methods: We performed a systematic review of literature indexed in MEDLINE of studies that used *Trichomonas* culture as the reference standard (9,882 patients, 35 studies). Level I studies (5,047 patients, 13 studies) fulfilled at least two of three criteria: 1) consecutive patients were evaluated prospectively, 2) decision to culture was not influenced by test results, and 3) there was independent and blind comparison to culture.

Results: The sensitivity of the polymerase chain reaction technique (PCR) was 95% (95% CI 91% to 99%), and the specificity was 98% (95% CI 96% to 100%). One study was classified as Level I evidence (52 patients). The sensitivity of the enzyme-linked immunosorbent assay was 82% (95% CI 74% to 90%), and the specificity was 73% (95% CI 35% to 100%). The sensitivity of the direct fluorescence antibody was 85% (95% CI 79% to 90%), and the specificity was 99% (95% CI 98% to 100%). Sensitivities of culture media were 95% for Diamond's, 96% for Hollander, and 95% for CPLM.

Conclusions: The sensitivity and specificity of tests to diagnose trichomoniasis vary widely. Infect. Dis. Obstet. Gynecol. 8:248–257, 2000. © 2000 Wiley-Liss, Inc.

KEY WORDS

diagnosis; evidence-based medicine; meta-analysis; sensitivity and specificity; *Trichomonas*

Trichomonas vaginitis is one of the most common sexually transmitted disease, with 167 million new cases each year worldwide, 8 million of which occur in the United States.[1–3] *Trichomonas vaginalis* infection leads to symptomatic vaginitis and contributes to preterm labor, perinatal morbidity, and possible cervical dysplasia.[4–7] Moreover, trichomoniasis increases the risk of transmission of the human immunodeficiency virus by twofold.[8] Accurate, reliable, convenient, and inexpensive diagnostic tests are essential to reduce the incidence and impact of this important pathogen. Currently, the most convenient and widely used diagnostic test for trichomoniasis is the wet mount.[6,9,10] A positive wet mount is diagnostic because of its high specificity, whereas a negative test cannot exclude trichomoniasis because of its low sensitivity.[9,11,12]

Vaginal culture is considered the best test for the diagnosis of trichomoniasis and is the current reference standard.[6,10,13–15] The swab of the sample is immersed in culture broth and incubated at 37°C to maximize growth. Specimens are observed microscopically for presence of motile organisms; if no growth is observed, usually by 7 days, the culture is said to be negative. Unfortu-

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Clinical Study

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nately, culture media are not widely available to the practicing physician, requiring 2–7 days to obtain results. The InPouch TV,[16] a technique that has recently received attention, is a commercially available medium consisting of a two-chambered bag that allows culture and microscopic examination of the specimen. Other tests to identify *Trichomonas* include polymerase chain reaction (PCR), enzyme-linked immunoassay (ELISA), direct fluorescence antibody assay (DFA), enzyme immunoassay (EIA), dot-immunobinding (DIBA) assay, indirect fluorescent antibody (IFA) assay, agglutination test (AT), and stained smear techniques (Pappenheim stain, Papanicolaou smear).[6] The latter tests were not mentioned in the 1998 Center of Disease Control and Prevention (CDC) guidelines for the treatment of sexually transmitted diseases[17]; currently, no guideline regarding the diagnosis of trichomoniasis is available.

Clinical investigations may result in inaccurate estimates of sensitivity and specificity if: 1) no reference standard is used, 2) patients are not evaluated prospectively, 3) the test result or reference standard influences the decision to perform the comparison test, or 4) the tests are not examined blindly and independently.[18–21] In a recent meta-analysis of the wet mount and Papanicolaou smear for the diagnosis of trichomoniasis, Wiese et al.[12] found that 74 of 104 studies did not use a reference standard. Although several investigations have suggested the utility of other diagnostic tests for trichomoniasis, their methodologic validity has not been critically examined. We conducted a systematic review of other diagnostic tests for *Trichomonas* vaginitis in order to obtain overall estimates of test sensitivity and specificity. In addition, we reviewed the accuracy of various culture media. Our systematic review of the evidence may help with development of guidelines for the diagnosis of trichomoniasis.

SUBJECTS AND METHODS

We searched the MEDLINE database in all languages for articles published between January, 1976, and November, 1998, describing diagnostic tests for vaginal trichomoniasis in humans (Ovid 7.05; Ovid, Technologies Inc., New York, NY). The key words to identify trichomoniasis were: explode (exp) *Trichomonas*, exp *Trichomonas* infections, *Trichomonas vaginalis*, and *Trichomonas* vaginitis. Any terms under each subheading were also retrieved. The text word *Trichomonas* and the wildcard word trichomon$ were also searched. The key words to identify diagnostic tests were: exp sensitivity and specificity, exp diagnostic errors, diagnostic tests routine, multiphasic screening, likelihood functions, diagnosis-differential, false-positive reactions, exp false-negative reactions, exp diagnosis, receiver operating curve, sensitivity (text word), and specificity (text word).[22,23] References listed in these published studies and in recent review articles were retrieved.[6,13,24] The search yielded 584 articles. We used Biblio-Link II and Procite software (Research Information Systems, Carlsbad, CA) to catalog references.

Two investigators reviewed each title and abstract independently to screen for eligible studies. Articles were reviewed entirely when agreement on eligibility could not be resolved by consensus among four investigators. We excluded 436 articles: 402 did not describe diagnostic tests, and 34 lacked a reference standard. The kappa regarding the appropriateness of exclusion was 0.71. Values of kappa reflect agreement that is slight (0 to <0.2), fair (0.2 to <0.4), moderate (0.4 to <0.6), substantial (0.6 to <0.8), or almost perfect (0.8 to 1).[25]

Two investigators independently examined the remaining 148 articles. We excluded 113 articles without disagreement: Fifty did not describe diagnostic tests, 12 could not be translated (written in Slovak, Polish, Russian, Korean, or Czech), 43 lacked a reference standard, and eight pertained to the wet mount or the Papanicolaou smear. Thus, we selected 35 articles for analysis.[11,16,26–58] We had no disagreement regarding the inclusion of articles. One publication used two study designs.

Quality Criteria for Validity of Studies

The reference standard was trichomonads culture in one or more media with/without the wet mount; i.e., trichomonas was said to be present when the organism was identified in one or more culture media or when the motile organism was seen in the wet mount. The wet mount alone was not considered a reference standard. We included only studies that sampled the vagina (Table 1). Culture media reviewed either were prepared in the individual laboratories or were commercially available (such as Diamond's medium from Carr Scarborough Microbiologicals, Stone Mountain, GA; InPouch TV

TABLE 1. Summary of studies included in the metaanalysis

Reference	Year	Quality criteria satisfied[1]	Setting[2]	Disease prevalence (%)	Sample size (n)	Reference standard
Level I						
Boeke et al. (26)	1993	1, 2	General clinic	6	667	CPLM[4] (cervical, vaginal)
Sharma et al. (27)[3]	1991	1, 2	Specialty clinic	7	1,000	Diamond, wet mount
Beal et al. (28)	1992	1, 2	Specialty clinic	9	710	Oxoid, Hollander, wet mount
Briselden et al. (29)	1994	1, 2, 3	STD clinic	9	170	Diamond, wet mount
Levi et al. (16)	1997	1, 2	STD clinic	10	715	Diamond, InPouch TV[5]
Jeremias et al. (30)	1994	1, 2	General clinic	12	52	Diamond
Krieger et al. (31)	1988	2, 3	STD clinic	15	600	Diamond, Feinberg Wittington
Schmid et al. (32)	1989	1, 2	STD clinic	27	375	Diamond, Kupferger-Trichosel, Kupferger-STS, Difco-Kupferger, Lash
Bickley et al. (11)	1989	1, 2, 3	STD clinic	37	104	Diamond, wet mount
de Carli et al. (33)	1987	1, 2	STD clinic	38	200	Diamond, wet mount
Watt et al. (34)	1986	1, 2	STD clinic	47	177	Diamond
Philip et al. (35)	1987	1, 2	STD clinic	49	177	Diamond, wet mount
Spence et al. (36)	1980	1, 2, 3	STD clinic	50	100	Hollander, wet mount
Subtotal				16	5,047	
Level II						
Madico et al. (37)	1988	2	General clinic	7	350	InPouch TV[5]
Shaio et a. (38)	1997	2	Specialty clinic	8	378	Agar
Yule et al. (39)	1987	2	STD clinic	9	482	Diamond
Lin et al. (40)	1997	2	Specialty clinic	10	165	Agar
Carney et al. (41)	1988	2	Specialty clinic	11	395	Oxoid, wet mount
Draper et al. (42)	1993	2	Specialty clinic	15	232	Diamond, InPouch TV[5], wet mount
DeMeo et al. (43)	1996	2	General clinic	15	615	Diamond, wet mount
Heine et al. (44)	1997	2	STD clinic	16	300	Trichosel broth, wet mount
Schwebke et al. (45)	1997	2	STD clinic	26	100	InPouch TV[5], wet mount
Smith et al. (46)	1986	2	STD clinic	30	105	Hollander
Imandel et al. (47)	1985	2	Specialty clinic	30	125	Oxoid, diphasic egg, Merck, wet mount
Gelbart et al. (48)	1989	2	Specialty clinic	32	163	Diamond, Kupferger, wet mount
Garber et al. (49)	1987	2	STD clinic	41	227	Diamond, McCoy cell
Thomason et al. (50)	1988	2	General clinic	42	88	Kupferger, Hirsh, wet mount
Gombosova et al. (51)	1990	2	Not described	78	245	Diamond
Subtotal				20	3,970	
Level III						
Ohliemeyer et al. (52)	1998	—	General clinic	13	268	Diamond
Mason (53)	1979	—	Specialty clinic	26	200	Agar
Su (54)	1982	—	STD clinic	44	54	Diamond
Lisi et al. (55)	1988	—	General clinic	55	66	Feinberg Wittington, wet mount
Bozner et al. (56)	1992	—	General clinic	57	49	Diamond
Weinberger et al. (57)	1993	—	Specialty clinic	73	60	Diamond, wet mount
Romia et al. (58)	1991	—	Specialty clinic	79	118	Diamond, wet mount
Sharma et al. (27)[3]	1991	—	Specialty clinic	98	50	Diamond
Subtotal				42	865	
Total				20	9,882	

[1]Criteria: 1, prospective evaluation of consecutive patients; 2, test results did not influence the decision to perform trichomonas culture; 3, test and trichomonas culture were examined independently and blindly.
[2]Specialty clinic, urology, obstetrics, gynecology, parasitology; STD, sexually transmitted diseases.
[3]Same article which used two study designs.
[4]CPLM (cysteine-peptone-liver medium).
[5]InPouch TV (proteose-peptone-medium).

from Bio Med Diagnostics Inc., Santa Clara, CA; Trichosel broth from Becton-Dickinson Microbiology Systems, Cockeysville, MD).

Studies were classified as Level I when they explicitly fulfilled at least two of three validity criteria: 1) consecutive patients were evaluated prospectively, 2) the test result did not influence the decision to perform the reference standard, and 3) the test of interest and reference standard were blinded and independently examined (Table 2).[18] Studies that fulfill these methodologic criteria are more likely to provide accurate estimates of sensi-

TABLE 2. Level of Evidence

Methodologic criteria
A reference standard is used
Consecutive patients are evaluated prospectively
Test result does not influence the decision to perform the reference standard
Test and reference standard are examined blindly and independently
Level I: Reference standard and two or more other criteria
Level II: Reference standard and one other criterion
Level III: Reference standard

tivity and specificity.[18] Studies were classified as Level II or III, respectively, when any one, or none, of the criteria was fulfilled.

The articles were randomly distributed among raters with expertise in evidence-based medicine. Two raters independently abstracted validity criteria and data from 2 × 2 contingency tables. Disagreement was resolved by consensus among four raters examining the full article. The kappa interrater agreement for the three study validity criteria were 0.48 for consecutive patient evaluation, 0.17 for influence to perform the reference standard, and 0.61 for test and reference standard independent evaluation.

Statistical Analysis

Prevalence, sensitivity, specificity, positive and negative predictive values, and likelihood ratios were calculated. Homogeneity of sensitivity and specificity between studies was explored with the χ^2 test.[59–61] Studies were considered homogeneous when the result of an individual study was mathematically compatible with the results of any of the others. We used a random-effects model to pool estimates of sensitivity and specificity.[59] Statistical methods are not available to pool likelihood ratios, so a weighted likelihood ratio could not be calculated.[18,61–65] We calculated an overall likelihood ratio positive (LR^+) by using pooled estimates of sensitivity and specificity, LR^+ = sensitivity/(1 − specificity). SPSS 8.0 software was used to perform statistical analyses (SPSS Inc., Chicago, IL).

RESULTS

Overall, 31% of diagnostic test studies utilized a reference standard (35/112 studies; Table 1). The validity criteria were reported in 33% of studies for consecutive patients and were evaluated prospectively; 78% of studies for the test result did not influence the decision to perform trichomonas culture as a reference standard; and 11% of studies for the cultures were examined independently and blindly. Table 1 shows the characteristics of the 35 articles (9,882 patients); one publication used two study designs. Thirteen studies (36%) were classified as Level I (5,047 patients), 15 (42%) as Level II (3,970 patients), and eight (22%) as Level III (865 patients). No consistent details of patient information across studies were available from the original papers. Asymptomatic patients accounted for 11% of the reports, patients with/without symptoms 64% (no breakdown of estimates among groups provided), and the remainder of the reports did not specify whether patients were symptomatic or not.

PCR Technique

Six studies examined the test characteristics of the PCR (1,973 patients; Table 3). The pooled sensitivity was 95% (95% CI 91% to 99%), the pooled specificity was 98% (95% CI 96% to 100%), and the LR^+ was 48. One study was classified as Level I (52 patients), five as Level II (1,921 patients), and none as Level III. The overall estimates of sensitivity were homogeneous. The overall estimates of specificity were heterogeneous.

ELISA

Five studies examined the test characteristics of the ELISA technique (806 patients; Table 3). The pooled sensitivity was 82% (95% CI 74% to 90%), the pooled specificity was 73% (95% CI 35% to 100%), and the LR^+ was 3. One study was classified as Level I (177 patients), one as Level II (395 patients), and three as Level III (234 patients). The overall estimates of sensitivity and specificity were heterogeneous.

DFA Technique

Three studies examined the test characteristics of the DFA technique (809 patients; Table 3). The pooled sensitivity was 85% (95% CI 79% to 90%), the pooled specificity was 99% (95% CI 98% to 100%), and the LR^+ was 85. Two studies were classified as Level I (704 patients), one as Level II (105 patients), and none as Level III. The overall esti-

TABLE 3. Accuracy of tests to diagnose Trichomonas Vaginitis

Test/reference	Level	Prevalence (%)	Sensitivity Percent	Sensitivity (n/n)	Specificity Percent	Specificity (n/n)	Likelihood ratio positive	Likelihood ratio negative	Positive predictive value (%)	Negative predictive value (%)
PCR										
Jeremias et al. (30)	I	12	100	(6/6)	98	(45/46)	46	0.00	86	100
Madico et al. (37)	II	7	96	(22/23)	95	(310/327)	18	0.05	56	100
Shaio et al. (38)[1]	II	8	100	(31/31)	100	(347/347)	∞	0.00	100	100
Shaio et al. (38)[2]	II	8	100	(9/9)	100	(104/104)	∞	0.00	100	100
Lin et al. (40)	II	10	100	(16/16)	100	(149/149)	∞	0.00	100	100
DeMeo et al. (43)	II	15	89	(85/95)	100	(519/520)	465	0.11	99	98
Heine et al. (44)	II	16	90	(44/49)	95	(239/251)	19	0.11	79	98
Pooled total			95		98*					
95% CI			91 to 99		96 to 100					
Range		8 to 16	89 to 100		95 to 100		19 to ∞	0 to 0.11	79 to 100	98 to 100
ELISA										
Watt et al. (34)	I	47	77	(65/84)	100	(93/93)	∞	0.23	100	83
Carney et al. (41)	II	11	95	(40/42)	99	(351/353)	168	0.05	95	99
Lisi et al. (55)	III	55	89	(32/36)	97	(29/30)	27	0.11	97	88
Romia et al. (58)	III	79	75	(70/93)	60	(15/25)	2	0.41	88	39
Sharma et al. (27)	III	98	76	(37/49)	0	(0/1)	1		97	0
Pooled total			82*		73*					
95% CI			74 to 90		35 to 100					
Range		11 to 98	75 to 95		0 to 100		1 to ∞	0.05 to 0.41	88 to 100	0 to 99
DFA										
Krieger et al. (31)	I	15	86	(76/88)	99	(509/512)	147	0.14	96	98
Bickley et al. (11)	I	37	84	(32/38)	98	(65/66)	56	0.16	97	92
Smith et al. (46)	II	30	81	(25/31)	99	(73/74)	60	0.20	96	92
Pooled total			85		99					
95% CI			79 to 90		98 to 100					
Range		15 to 37	81 to 86		98 to 99		56 to 147	0.14 to 0.20	96 to 97	92 to 98
EIA; Yule et al. (39)	II	9	93	(41/44)	98	(429/438)	45	0.07	82	99
Pappenheim stain; Garber et al. (49)	II	41	83	(77/93)	99	(132/134)	55	0.17	97	89
DIBA; Gombosova et al. (51)	II	78	92	(175/191)	93	(50/54)	12	0.09	98	76
IFA; Mason (53)	III	26	92	(48/52)	62	(92/148)	2	0.12	46	96
IFA; Romia et al. (58)	III	79	87	(81/93)	80	(20/25)	4	0.16	94	63
IFA, IgA; Su (54)	III	44	8	(2/24)	100	(30/30)	∞	0.92	100	58
IFA, IgE; Su (54)	III	44	13	(3/24)	100	(30/30)	∞	0.88	100	59
IFA, IgG; Su (54)	III	44	71	(17/24)	77	(23/30)	3	0.38	71	77
IFA, IgM; Su (54)	III	44	4	(1/24)	100	(30/30)	∞	0.96	100	57
AT; Romia et al. (58)	III	79	65	(60/93)	96	(24/25)	16	0.37	98	42

[1]Symptomatic patients.
[2]Asymptomatic patients.
*Denotes heterogeneity of data ($P < 0.05$).

mates of sensitivity and specificity were homogeneous.

Other Techniques

Six studies examined nine other techniques (Table 3). The sensitivities ranged from 4% to 93%, and the specificities ranged from 62% to 100%. The LR^+ ranged from 2 to infinity. No studies were classified as Level I, three as Level II, and three as Level III.

Culture Media

Twenty studies examined the test characteristics of 11 culture media techniques (Table 4). The pooled

TABLE 4. Accuracy of culture media to diagnose trichomonas vaginitis

Culture media/reference	Level	Prevalence (%)	Sensitivity Percent	Sensitivity (n/n)
Diamond				
Sharma et al. (27)[1]	I	7	99	(67/88)
Levi et al. (16)	I	10	88	(65/74)
Schmid et al. (32)	I	27	90	(92/102)
Schmid et al. (32)[1]	I	27	97	(99/102)
Bickley et al. (11)[1]	I	37	95	(36/38)
de Carli et al. (33)	I	38	97	(73/75)
Philip et al. (35)[1]	I	49	98	(84/86)
Draper et al. (42)	II	15	91	(31/34)
DeMeo et al. (43)[1]	II	15	98	(93/95)
Garber et al. (49)	II	60	98	(53/54)
Weinberger et al. (57)[1]	III	73	98	(43/44)
Pooled total			95*	
95% CI			93 to 98	
Range		7 to 73	88 to 99	
Hollander				
Beal et al. (28)	I	9	97	(60/62)
Spence et al. (36)	I	50	96	(48/50)
Pooled total			96	
95% CI			93 to 100	
Range		9 to 50	96 to 97	
CPLM				
Boeke et al. (26)[2]	I	6	92	(34/37)
Boeke et al. (26)	I	6	97	(36/37)
Pooled total			95	
95% CI			80 to 100	
Range		6	92 to 97	
InPouch TV				
Levi et al. (16)	I	10	82	(61/74)
Draper et al. (42)	II	15	88	(30/34)
Schwebke et al. (45)[3]	II	26	85	(22/26)
Schwebke et al. (45)[4]	II	26	88	(23/26)
Ohlemeyer et al. (52)	III	13	81	(29/36)
Pooled total			84	
95% CI			79 to 89	
Range		7 to 26	81 to 88	
Oxoid				
Beal et al. (28)	I	9	89	(55/62)
Carney et al. (41)	II	11	76	(32/42)
Imandel et al. (47)	II	30	81	(30/37)
Pooled total			83	
95% CI			76 to 90	
Range		9 to 30	76 to 89	
Kupferberg-Trichosel				
Schmid et al. (32)	I	27	75	(77/102)
Gelbart et al. (48)	II	32	77	(40/52)
Thomason et al. (50)	II	42	86	(32/37)
Pooled total			78	
95% CI			72 to 85	
Range		27 to 42	75 to 86	
Other media				
Merck; Imandel et al. (47)	II	30	76	(28/37)
Diphasic egg; Imandel et al. (47)	II	30	89	(33/37)
Hirsh; Thomason et al. (50)	II	42	81	(30/37)
McCoy cell; Garber, et al. (49)	II	60	96	(52/54)
Feinberg Wittington; Lisi et al. (55)	III	55	97	(35/36)
Pooled, all cultures			90	
95% CI			87 to 93	
Range			75 to 99	

[1]Diamond-modified. [2]Cervix sampling. [3]Self-collected sample. [4]Collected by physician. *Denotes heterogeneity of data ($P < 0.05$).

sensitivity for all studies was 90% (95% CI 87% to 93%). The Diamond's culture medium was examined in 10 studies (3,568 patients; Table 4). The pooled sensitivity was 95% (95% CI 93% to 98%). Six studies were classified as Level I (2,571 patients), three as Level II (937 patients), and one as Level III (60 patients). The overall estimates of sensitivity were heterogeneous.

The Hollander culture medium was examined in two studies (810 patients; Table 4). The pooled sensitivity was 96% (95% CI 93% to 100%). Both studies were classified as Level I. The overall estimates of sensitivity were homogeneous.

The CPLM culture medium was examined in one study (667 patients; Table 4). The pooled sensitivity was 95% (95% CI 80% to 100%). Both studies were classified as Level I. The overall estimates of sensitivity were homogeneous.

The InPouch TV technique was examined in four studies (1,315 patients; Table 4). The pooled sensitivity was 84% (95% CI 79% to 89%). One study was classified as Level I (715 patients), two as Level II (332 patients), and one as Level III (268 patients). The overall estimates of sensitivity were homogeneous.

DISCUSSION

We performed a systematic review of tests comparing to a reference standard to help with the development of guidelines for the diagnosis of trichomoniasis. Ideally a test should have high sensitivity and specificity and be easily available, simple to perform, and inexpensive. Currently, for the diagnosis of trichomoniasis, the wet mount is the least costly to perform, yet its sensitivity is poor. In the latest guidelines for the treatment of sexually transmitted diseases, the CDC reports that "The motile *T. vaginalis* is identified easily in the saline specimen [and] culture for *T. vaginalis* is more sensitive than microscopic examination."[17] However, no guidance was provided regarding other diagnostic tests.

This systematic review shows that PCR for the diagnosis of trichomoniasis has high sensitivity, specificity, and LR^+. The narrow confidence intervals indicate consistent results between studies. However, most of the data were derived from Level II studies. Self-collection of the specimen[66] and rapid results[40] are some of the advantages of this technique. Women with asymptomatic trichomoniasis serve as a reservoir for continuing disease transmission. Therefore, perhaps PCR would be most useful in mass screening of trichomoniasis, similarly to its use in the detection of *Chlamydia trachomatis*.[67] Detection of nonviable organisms in patients previously treated and unavailability in most institutions are presently some of the limitations of the PCR technique. In the future, PCR may be superior to culture. Other techniques such as ELISA and DFA have lower sensitivities compared to PCR or culture.

Our study raises an important issue: What should the culture reference standard be for the diagnosis of vaginal trichomoniasis? Our systematic review shows that the Diamond, Hollander, and CPLM culture media seem to be the most accurate, with sensitivities over 95%. Therefore, they could be used as reference standards. Among these, Diamond's medium produces the maximal *Trichomonas* growth in vitro.[68] Other culture media have lower sensitivities and so probably should not be used as reference standards. Some authors have recommended selective media (Diamond's, Trichosel, Hollanders, InPouch TV) as superior for culture of *Trichomonas*,[6,10] whereas others have not.[13–15] All of the Level I studies included in this study utilized one of the culture media with the highest sensitivities (Diamond, Hollander, CPLM). Although the cost of these culture media is not high, most practicing physicians are not aware of their existence, and few hospitals have them available. Cultures could detect trichomonads at 48–72 hr, but it may take up to 7 days to obtain the final result. A delay in therapy while waiting for results is not desirable. *Trichomonas* culture should be used when the wet mount is negative and the clinical suspicion is still present. Culture should also be obtained to confirm a positive Papanicolaou smear in settings of low to intermediate prevalence.[12] The estimates of sensitivity for culture should be interpreted cautiously. The reference standard in some studies was the culture medium itself with the wet mount, which may yield higher estimates of sensitivity for the culture, whereas in other studies the reference standard was multiple culture media with/without the wet mount, which may yield lower estimates of sensitivity. As an example, the sensitivity of the Diamond's medium ranged from 95% to 99% for the former scenario and 88% to 97% for the latter.

Our systematic review has several strengths. We used a systematic approach in the evidence-based framework, including studies that utilized a reference standard. Studies without a reference standard when one exists are uninterpretable. We also used explicit validity criteria to assess the level of the evidence.[18,19] Finally, multiple raters abstracted data to avoid observation bias. Our study has certain limitations. The methodologic quality criteria in the studies were not always explicitly described, resulting in less-than-ideal interrater agreements. We address this by discussing the criteria among four authors but acknowledge that other reviewers might reach different decisions. The study design was not uniform among reports, and not all estimates were homogeneous. We used a random-effect model to attempt to correct for heterogeneity among such studies,[59] but we caution the reader to examine the primary data instead of the pooled estimates.

In summary, PCR is a promising technique with sensitivity equal to or better than that of culture. However, more Level I studies are needed. The CDC should make a uniform recommendation with the appropriate reference standard for the diagnosis of trichomoniasis. In the meantime, it seems prudent to use only the culture media with the highest sensitivity as a reference standard (Diamond, Hollander, or CPLM).

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