

## Streptococcal Pharyngitis: Impact of a High-Sensitivity Antigen Test on Physician Outcome

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**The purpose of the present study was to determine whether the availability of results from a high-sensitivity, rapid test for group A streptococci (Strep A OIA; BioStar, Inc., Boulder, Colo.) improves physician outcome. The study population included 465 consecutive patients with symptoms of acute pharyngitis seen in two outpatient clinics in a large suburban medical center; one clinic, a walk-in clinic (WIC), primarily saw adult patients, and one clinic, a pediatric and adolescent medicine clinic (PED), primarily saw pediatric patients. We measured improvement in physician outcome by comparing physician intent for prescribing an antibiotic based on clinical impression with physician practice once the results of the Strep A OIA were known. Based upon intent, the physicians seeing WIC patients (WIC physicians) would have prescribed an appropriate antibiotic course for 42% of patients with cultures positive for group A beta-hemolytic streptococci (GABHS) and 61% of patients with cultures negative for GABHS. After receiving the results of the Strep A OIA, WIC physicians prescribed an appropriate antibiotic course for 81% of patients with positive cultures and 72% of patients with negative cultures. Based upon intent, the physicians seeing PED patients (PED physicians) would have prescribed an appropriate antibiotic course for 35% of patients with positive cultures and 77% of patients with negative cultures. After receiving the results of the Strep A OIA, PED physicians prescribed an appropriate antibiotic course for 90% of patients with positive cultures and 81% of patients with negative cultures. Based on a 14.5% prevalence of GABHS among WIC patients, Strep A OIA improved the overall WIC physician outcome from 58 to 74%. Based on a 31.5% prevalence of GABHS among PED patients, Strep A OIA improved the PED physician outcome from 64 to 84%. Had Strep A OIA alone guided therapeutic choice, physicians would have prescribed an appropriate antibiotic course for 95% of the patients at the time of the initial encounter. We conclude that the use of Strep A OIA improves physician outcome.**

Pharyngitis is one of the most common outpatient illnesses. The majority of cases in both pediatric and adult patients are of viral etiology. However, pharyngitis caused by the group A streptococcus is the target of most diagnostic and therapeutic strategies. The advent of highly sensitive direct test methods for the detection of this pathogen presents an opportunity to examine the influence of rapidly available test results on physician performance.

Early treatment of group A streptococcal pharyngitis is believed to shorten the duration of symptoms (20, 25, 27), decrease the incidence of suppurative complications (2, 7), and diminish the probability of spread (26). In addition, appropriate treatment of group A beta-hemolytic streptococcal (GABHS) pharyngitis significantly reduces the risk of development of acute rheumatic fever, a complication that can be prevented, by and large, if an adequate course of antibiotic is received within 9 days after the onset of symptoms (12, 34). Although there have been recent local resurgences of rheumatic fever (4), this still remains a rare complication in the United States.

A variety of algorithms for management of patients with pharyngitis have been devised over the years. In one extreme, all patients in specific epidemiologically identified risk groups might receive antibiotics without ancillary diagnostic testing. This strategy ensures that a maximum number of patients with group A streptococcal pharyngitis will receive appropriate

therapy. It also exposes the maximum number of patients to unnecessary antibiotics and thus generates the maximum number of unnecessary adverse drug reactions. The opposite extreme withholds therapy until adequate diagnostic information is available in the form of a bacteriologic culture result. While the latter approach minimizes the number of unnecessary adverse drug reactions, it also relies heavily on adequate follow-up and delays institution of appropriate therapy by 2 to 3 days. In practice, many physicians rely on a combination of clinical judgment and diagnostic testing and admit to over-treatment (5, 8).

The use of rapid tests for the presence of group A streptococci offers an important bridge between these two extremes. Test results can be available while the patient is in the physician's office, and decisions regarding management can be based on objective evidence. In reality, the sensitivity of the various rapid methods has not been equal to that of a carefully performed culture.

Recently, several tests with high sensitivities for the detection of group A streptococci have been developed. The Strep A OIA (BioStar, Inc., Boulder, Colo.) is one such test that lends itself well to use in an office practice (16). The test is an optical immunoassay that allows the direct visual detection of the binding reactions between antigens and antibodies. The Strep A OIA relies on 0.3 M acetic acid for antigen extraction. Although the test's reported sensitivity ranges from 77.0 to 97.4%, most published studies have reported sensitivity equal to or exceeding that of standard throat swab specimen cultures on sheep blood agar (1, 9–11, 14, 16–19, 29–32).

Few studies have examined the influence of rapid tests on physician management of patients with a chief complaint of

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sore throat, and none have used a high-sensitivity assay. The majority of studies whose results have been published have been based on questionnaires (3), decision analysis (13, 23), and retrospective reviews comparing antibiotic use before and after the introduction of rapid test methods (6, 24, 33) or with and without positive direct test results (21, 22). A single study examining management before and after rapid test results were known for the same patient was conducted with a Native-American population in which the incidence of rheumatic fever was high (45 cases/100,000 population) and follow-up was frequently difficult (28). The assays used in these studies were latex agglutination, a method with good specificity but marginal sensitivity. Thus, their overall accuracy is less than that for tests that use newer methodologies. Nonetheless, all of these studies suggested that the introduction of a rapid test improves physician effectiveness in deciding whether to use antimicrobial agents, particularly for patients with positive cultures.

The purpose of this study was to determine whether physician outcome is improved by the use of a high-sensitivity, rapid test for group A streptococci. We measure improvement in physician outcome by comparing physician intent based on clinical impression with physician practice once the test results are received. The physicians' antibiotic prescription practices were the principal focus for analysis. The settings for the study were a pediatric and adolescent medicine practice (PED) and an adult walk-in clinic (WIC) in a large, suburban medical center. The physicians in the former practice (PED physicians) provide care to a population with a high prevalence of group A streptococcal pharyngitis. The physicians in the latter group (WIC physicians) provide care to a population with a low prevalence of group A streptococcal pharyngitis. Both patient groups are characterized by a low incidence of acute rheumatic fever and virtually 100% successful follow-up for adjustment of antibiotic therapy after the results of diagnostic testing have been reported.

#### MATERIALS AND METHODS

**Patient selection and specimen collection.** Consecutive patients from PED or WIC at Lahey Clinic, Burlington, Mass., for whom throat swab specimens were cultured for group A streptococci were eligible for enrollment in the study. We excluded from the study a very small number of patients who refused to wait for results of rapid testing.

One of 6 PED physicians or 1 of 12 WIC physicians examined all patients. Physicians collected a pharyngeal specimen with a synthetic-fiber swab (Culturette System; Baxter Diagnostics, Inc., Deerfield, Ill.). They returned the swab to its transport tube, which contained a pledget saturated with transport medium. The physician then asked the patient and/or accompanying parent to deliver the specimen to the Microbiology Laboratory and return to the clinic to await the results.

**Clinical data collection.** At the time of initial physical examination, each physician completed a short patient data sheet. The physician documented the following: (i) age, (ii) sex, and (iii) pertinent medical history including prior antibiotic use within 2 weeks of the visit and known exposure to group A streptococci. The physician then stated his or her presumptive diagnosis and treatment plan and instructed the patient to take the data sheet along with the specimen to the laboratory.

**Microbiology.** The laboratory staff inoculated a Trypticase soy 5% sheep blood agar plate (BAP; Remel, Lenexa, Kans.) immediately upon specimen receipt. They applied a sterile coverslip to the primary streaking area to provide anaerobic conditions and placed the culture in a 35°C room air incubator. A technologist then used the same swab to perform a rapid test for group A streptococci using the BioStar Strep A OIA direct antigen test (BioStar). Technologists performed the test according to the manufacturer's directions.

Technologists examined the BAP cultures at 24 and 48 h for evidence of beta-hemolytic streptococci. If present, the colonies were quantitated as rare (<10 colonies), few (10 to 25 colonies), moderate (25 to 50 colonies), or many (>50 colonies). They transferred suspect colonies to pure culture (if necessary) and grouped each isolate using a latex agglutination reagent (Streptex; Burroughs Wellcome, Research Triangle Park, N.C.).

Following the plating procedure, the technologist aseptically removed the pledgets from the transport tubes and placed them in a tube of Todd-Hewitt

enrichment broth (THB). The tubes were incubated for 18 to 24 h in a 35°C room air incubator and were subcultured onto a BAP. A technologist examined the plates following incubation for 18 to 24 h at 35°C. Suspect colonies were grouped as described above. The THB result was used as the reference method for both Strep A OIA results and culture on BAP.

**Therapeutic strategies.** Physicians from both groups followed one of the three therapeutic strategies described below. Each strategy had one or more potentially adverse outcomes associated with it.

(i) **Strategy 1.** The physician prescribed a 10-day course of antibiotic at the time of the visit. A member of the nursing staff notified the patient or the patient's parent by telephone that the antibiotic should be discontinued if the culture was later reported as negative for group A streptococci. Patients with negative cultures would thus receive therapy for a minimum of 2 days and be at unnecessary risk for an adverse drug reaction.

(ii) **Strategy 2.** The physician prescribed a 2- to 3-day course of antibiotic at the time of the visit. The patients with negative cultures would thus receive antibiotic for 2 days and be at unnecessary risk for an adverse drug reaction. No attempt was made to contact the patient or the patient's parents directly if the culture was negative for group A streptococci. If the culture was positive for group A streptococci, a member of the nursing staff would notify the patient or patient's parent by telephone and an additional 8 days of antibiotic therapy would be prescribed. The members of the latter group would be at risk for developing nonsuppurative complications if they were lost to follow-up.

(iii) **Strategy 3.** The physician prescribed no antibiotic at the time of the visit. A member of the nursing staff would notify the patient or the patient's parent by telephone, and a 10-day course of therapy would be prescribed if the result of culture was positive for group A streptococci. Patients in this group with positive cultures would have been at risk for both suppurative and nonsuppurative complications if they were lost to follow-up, and therapy would be delayed.

**Assessment of clinical outcome.** A technologist communicated the Strep A OIA results and all positive culture results by telephone to the physician as soon as they were available. In addition, the laboratory issued a written report of results at 24-h intervals. The physician recorded his or her management strategy in the patient's medical record after the results of the Strep A OIA test and/or culture were known.

For the purposes of this study, we define *clinical accuracy* as the measure of physician accuracy in establishing a correct presumptive diagnosis as referenced against the THB culture result. We define *therapeutic accuracy* as the measure of physician accuracy in prescribing the therapeutic course as referenced against the THB culture result. For the purposes of this analysis, we define a desirable physician outcome as either a prescription for a 10-day course of antibiotic for a patient with a culture positive for GABHS or no antibiotic for a patient with a culture negative for GABHS. We define a prescription for a 2- to 3-day course of antibiotics pending culture results as an undesirable physician outcome whether the resulting culture was positive or negative. Similarly, we considered no antibiotic for a patient with a culture positive for GABHS or a 10-day course of antibiotic for a patient with a culture negative for GABHS as an undesirable physician outcome.

We assessed therapeutic accuracy at three points within each patient interaction: (i) after the physician examined the patient but before laboratory results were available, (ii) after the results of the Strep A OIA were known, and (iii) after the results of the THB culture were known. The patient data sheet served as the basis for the first measurement. The patient medical record served as the basis for the last two measurements.

**Statistical analyses.** A patient was considered to have group A streptococcal pharyngitis only if group A streptococci were isolated from the THB culture. Test characteristics (sensitivity, specificity, negative and positive predictive values, and accuracy) were calculated by using standard definitions (15). We applied the chi-square test with Yates' correction to 2-by-2 contingency tables describing pre- and posttest therapeutic accuracies.

#### RESULTS

**Patient population.** There were 465 patients who met the eligibility requirements for inclusion in the study; 413 of these patients had clear clinical symptoms of pharyngitis. There were 202 male patients and 263 female patients. WIC physicians examined 179 patients, and PED physicians examined 286 patients. The mean age of the patients seen in WIC was 34.3 years. The mean age of patients seen in PED was 9.4 years. Sixteen patients reported taking antibiotics within 2 weeks of the time that they were seen in the clinics, and 54 reported exposure to group A streptococci.

**Performance characteristics of the BioStar Strep A OIA.** THB did not identify additional positive specimens compared to the number identified by primary BAP culture. Consequently, the two results are considered equivalent for the purpose of this report.

TABLE 1. Comparison of BioStar Strep A OIA with culture for detection of group A streptococcus<sup>a</sup>

Culture result	No. of patients with the following Strep A OIA result:		Total
	Positive	Negative	
Positive	101	15	116
Negative	9	340	349

<sup>a</sup> Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 87.1, 97.4, 91.8, 95.8, and 94.8%, respectively.

The results of culture and Strep A OIA are presented in Table 1. The prevalence of group A streptococci determined by culture was 14.5% among the WIC patients and 31.5% among the PED patients. The Strep A OIA detected 101 of 116 patients with positive cultures. Eleven of the 15 false-negative Strep A OIA results occurred for patients whose BAP cultures contained rare to few colonies of group A streptococci. Among the 349 patients with negative cultures, 9 had false-positive Strep A OIA results. Thus, the Strep A OIA was 87.1% sensitive and 97.4% specific in detecting group A streptococci in patients with positive cultures, had a positive predictive value of 91.8%, had a negative predictive value of 95.8%, and accurately predicted the culture result for 94.8% of the patients in the study population. When results for the two populations are considered separately, the test had positive predictive values of 91.7% for the WIC patients and 91.5% for the PED patients, negative predictive values of 97.3% for the WIC patients and 94.3% for the PED patients, and accurately predicted the culture results for 96.6% of the WIC patients and 94.3% of the PED patients.

**Clinical accuracy in predicting group A streptococcal pharyngitis.** We were able to evaluate 450 of the 465 patients for physician clinical accuracy. Fifteen patients (5 WIC patients and 10 PED patients) were eliminated because information was missing from their patient data sheets. There was no substantial difference between the two groups of physicians in terms of their ability to predict the presence of group A streptococci. The WIC physicians achieved clinical accuracy for 129 of the 174 (74.1%) WIC patients. They correctly classified 15

of 26 patients with positive cultures for group A streptococci and 114 of 148 patients with negative cultures. The PED physicians achieved clinical accuracy for 200 of the 276 (72.5%) PED patients. They correctly classified 46 of 86 patients who had positive cultures and 154 of the 190 patients who had negative cultures.

**Therapeutic accuracy based on clinical assessment.** The WIC physicians made a correct empirical choice for 101 of 174 patients, achieving therapeutic accuracy in 58% of the encounters. Twenty-six WIC patients were eventually culture positive for group A streptococci. Based on clinical assessment without the benefit of Strep A OIA, 11 of these 26 patients would have received a prescription for a full therapeutic course of antibiotic. A total of 148 patients were eventually culture negative for group A streptococci. Based on clinical assessment without the benefit of the Strep A OIA result, 58 of these 148 patients would have received antibiotic and thus would have been at risk of an unnecessary adverse drug reaction.

Among the 15 patients with positive cultures who would not have received a full course of therapy, 7 would have received 2 to 3 days of antibiotic therapy. These seven patients would not have experienced therapeutic delay but would have been at risk for development of nonsuppurative complications if they were lost to follow-up. The remaining eight would have experienced therapeutic delay, been at risk for loss to follow-up, and thus been at greater risk for developing both suppurative and nonsuppurative complications.

The PED physicians made a correct empirical choice for 177 of 276 patients, achieving therapeutic accuracy in 64% of the encounters. Eighty-six PED patients were eventually culture positive for group A streptococci. Based on clinical assessment without the benefit of Strep A OIA, 30 of these 86 patients would have received a prescription for a full therapeutic course of antibiotic. A total of 190 patients were eventually culture negative for group A streptococci. Based on clinical assessment without the benefit of the Strep A OIA result, 43 of these 190 patients would have received antibiotics and thus have been at risk for development of an unnecessary adverse drug reaction.

Among the 56 patients with positive cultures who would not have received a full course of therapy, 16 would have received 2 to 3 days of antibiotic therapy. These 16 patients would not

TABLE 2. Therapeutic strategies before and after availability of results of Strep A OIA: WIC patients

Physician outcome	Therapeutic choice before Strep A OIA result	Therapeutic choice after Strep A OIA result	No. (%) of events							
			When physician and Strep A OIA agree				When physician and Strep A OIA disagree			
			Physician presumes GABHS		Physician presumes not GABHS		Physician presumes GABHS		Physician presumes not GABHS	
			True positive <sup>a</sup>	False positive	True negative	False negative	True negative	False negative	True positive	False positive
Total			15 (11.3)	1 (0.8)	113 (85.0)	4 (3.0)	33 (80.5)	0 (0.0)	7 (17.1)	1 (2.4)
OIA result does not change therapy	No antibiotic 2 days 10 days	No antibiotic 2 days 10 days	0 0 10	0 0 0	79 3 10	3 0 0	1 1 12	0 0 0	1 0 1	0 0 0
OIA result changes planned 2- or 10-day therapy to no therapy	2 days 10 days	No antibiotic No antibiotic	0 0	0 0	10 0	1 0	14 3	0 0	0 0	0 0
OIA result changes no therapy or 2-day therapy to 10-day therapy	No antibiotic 2 days	10 days 10 days	0 5	0 1	8 0	0 0	1 1	0 0	4 1	0 1
OIA result creates uncertainty	No antibiotic 10 days	2 days 2 days	0 0	0 0	1 2	0 0	0 0	0 0	0 0	0 0

<sup>a</sup> Strep A OIA result versus culture result.



TABLE 3. Summary of WIC physician outcome before and after results of the Strep A OIA were available<sup>a</sup>

Outcome	No. of patients	
	Pretest therapeutic accuracy	Posttest therapeutic accuracy
Desired outcome <sup>b</sup>	101	128
Adverse outcome <sup>c</sup>	73	46
Total	174	174

<sup>a</sup> We applied the chi-square test with Yates' continuity correction to test the hypothesis that the Strep A OIA had a significant impact on outcomes. We can reject the null hypothesis of no impact at the 99% confidence level.

<sup>b</sup> Defined as no antibiotic for patients with cultures negative for GABHS or 10 days of therapy for patients with cultures positive for GABHS.

<sup>c</sup> Defined as any antibiotic for patients with cultures negative for GABHS or no therapy or 2 days of therapy for patients with cultures positive for GABHS.

have experienced therapeutic delay but would have been at risk for development of nonsuppurative complications if they were lost to follow-up. The remaining 40 would have experienced therapeutic delay, would have been at risk for loss to follow-up, and thus would have been at risk for developing both suppurative and nonsuppurative complications.

**Therapeutic accuracy after results of the Strep A OIA were known.** The availability of an objective and reliable test result at the time of the patient visit prompted changes in the planned management strategies among physicians in both clinical settings. Based on the result of the Strep A OIA, 128 of the 174 WIC patients received appropriate therapy at the time of their visit, bringing the therapeutic accuracy from 58 to 74%. Table 2 details these changes, and Table 3 summarizes the observations.

Among WIC patients with positive cultures, 21 of 26 received prescriptions for a complete therapeutic course of antibiotic at the time of their clinic visit. Of the five remaining patients, only one had a positive Strep A OIA result.

Among WIC patients with negative cultures, 41 of 148 received antibiotic therapy, reducing the number of unnecessary antibiotic exposures from 58 to 41. Two of the 41 exposures were a consequence of false-positive Strep A OIA results.

We documented similar changes in the clinical management

for PED patients, 231 of the 276 of whom were accurately treated at the time of their visit. The Strep A OIA significantly improved therapeutic accuracy, moving from 64 to 84% when the results of the test were provided to the physician. Table 4 details these changes, and Table 5 summarizes the observations.

Among patients with positive cultures, 77 of 86 received prescriptions for a full therapeutic course of antibiotic, although 2 of the 77 had false-negative Strep A OIA results. The Strep A OIA was negative for the remaining nine patients, none of whom received an antibiotic. All nine patients would have experienced therapeutic delay and been at risk for developing suppurative and/or nonsuppurative complications if they were lost to follow-up. This is in contrast to 40 patients who would have experienced therapeutic delay and 56 patients who would potentially have been lost for follow-up without the availability of Strep A OIA results.

Among patients with negative cultures, 36 of 190 were discharged without receiving antibiotic therapy, thus reducing the number of unnecessary antibiotic exposures from 43 to 36. Discharge of 7 of the 36 patients was a consequence of false-positive Strep A OIA results.

Neither false-positive nor false-negative Strep A OIA results could be attributed to prior use of antibiotics. None of the patients with discrepant test results acknowledged the use of antibiotics within a 2-week period prior to their examination.

**Therapeutic accuracy after results of culture were known.** WIC and PED physicians achieved 100% follow-up with patients who were later identified as having positive cultures and who required additional antibiotic therapy. Therapeutic accuracy increased from 74% with the Strep A OIA to 76% for the WIC patients and 84% with the Strep A OIA to 87% for the PED patients. Culture did not alter the number of patients exposed unnecessarily to an antibiotic in either setting.

**Theoretic therapeutic accuracy based on Strep A OIA results.** By ignoring clinical judgment and selecting therapy based on Strep A OIA results alone, physicians would have achieved therapeutic accuracy for 94.8% of the patients. In the case of the WIC patients, therapeutic accuracy would have increased from 76 to 97%, the number of patients with unnecessary antibiotic exposures would have decreased from 23 to 2, and 4

TABLE 4. Therapeutic strategies before and after availability of results of the Strep A OIA: PED patients

Physician outcome	Therapeutic choice before Strep A OIA result	Therapeutic choice after Strep A OIA result	No. (%) of events							
			When physician and OIA agree				When physician and OIA disagree			
			Physician presumes GABHS		Physician presumes not GABHS		Physician presumes GABHS		Physician presumes not GABHS	
			True positive <sup>a</sup>	False positive	True negative	False negative	True negative	False negative	True positive	False positive
Total			44 (21.6)	2 (1.0)	149 (73.0)	9 (4.4)	34 (47.2)	2 (2.8)	31 (43.1)	5 (6.9)
OIA result does not change therapy	No antibiotic	No antibiotic	0		130	8	7		0	
	2 days	2 days	0		2		4		0	
	10 days	10 days	25	2	9	1	6	1	2	1
OIA result changes planned 2- or 10-day therapy to no therapy	2 days	No antibiotic	0		4		9		0	
	10 days	No antibiotic	0		0		4	1	0	
OIA result changes no therapy or 2-day therapy to 10-day therapy	No antibiotic	10 days	4		4				28	4
	2 days	10 days	15				2		1	
OIA creates uncertainty	No antibiotic	2 days	0		0		2		0	
	10 days	2 days	0		0		0		0	

<sup>a</sup> Strep A OIA result versus culture result.

TABLE 5. Summary of PED physician outcome before and after results of the Strep A OIA were available<sup>a</sup>

Outcome	No. of patients	
	Pretest therapeutic accuracy	Posttest therapeutic accuracy
Desired outcome <sup>b</sup>	177	231
Adverse outcome <sup>c</sup>	99	45
Total	276	276

<sup>a</sup> We applied the chi-square test with Yates' continuity correction to test the hypothesis that the Strep A OIA had a significant impact on outcomes. We can reject the null hypothesis of no impact at the 99% confidence level.

<sup>b</sup> Defined as no antibiotic for patients with cultures negative for GABHS or 10 days of therapy for patients with cultures positive for GABHS.

<sup>c</sup> Defined as any antibiotic for patients with cultures negative for GABHS or no therapy or 2 days of therapy for patients with cultures positive for GABHS.

patients would have been at risk for developing suppurative and/or nonsuppurative complications. In the case of PED patients, therapeutic accuracy would have increased from 87 to 93%, the number of patients with unnecessary antibiotic exposures would have decreased from 21 to 7, and 11 patients would have been at risk for developing suppurative and/or nonsuppurative complications. The levels of reduction in risk factors based on exclusive use of the test as a guide to therapy are presented in Table 6.

**Impacts of confounding diagnoses on therapeutic accuracy measurement.** Since this study is based on actual patient encounters, it is important to examine the impacts of confounding diagnoses on our assessment of therapeutic accuracy. We considered a confounding diagnosis to be a final diagnosis other than group A streptococcal pharyngitis for which empirical antibiotic therapy might be considered appropriate. Otitis media and chronic bronchitis, for example, would be included in this category. Among the 41 WIC patients with negative cultures who received antibiotics after the results of the Strep A OIA were available, 18 had alternative confounding diagnoses. If confounding diagnoses are taken into consideration, the number of unnecessary antibiotic exposures from physician use of the Strep A OIA decreases from 41 to 23.

Among the 36 PED patients with negative cultures who received antibiotics after the results of the Strep A OIA were available, 13 had alternative confounding diagnoses. When confounding diagnoses are taken into consideration, the number of unnecessary antibiotic exposures from physician use of the Strep A OIA decreases from 36 to 23.

## DISCUSSION

We conclude that the Strep A OIA is a highly sensitive and specific method for detection of group A streptococci directly from pharyngeal swabs. Although the test was not as sensitive as the culture method performed in this laboratory, it is almost certainly superior to culture performed by a less rigorous method. Authors of several recent studies (22–34) reported sensitivities ranging from 77.0 to 97.4%. Culture methods that use two plates and a THB culture for each patient tested appear to be the most sensitive approach, accounting for the lower sensitivity of the Strep A OIA when the Strep A OIA is compared to that culture method. However, few laboratories use such methods for culture of throat swab specimens.

We have prospectively examined the impact of a highly sensitive rapid test for the group A streptococcus on clinical outcome. We chose to follow physicians caring for two distinct patient populations, one largely comprising adults in whom group A streptococcal pharyngitis is a less common event and one comprising young children and adolescents who represent the group at highest risk of infection. It is worth emphasizing that clinical symptoms alone are not sufficient for the accurate diagnosis of group A streptococcal pharyngitis. This fact has been demonstrated repeatedly by a variety of investigators over the years and remains true today, as evidenced by our results. This was independent of the patient group under consideration.

The important goals in patient management are accurate separation of the patients with a treatable cause of pharyngitis from those without a treatable cause, treatment of those who are infected as soon as possible so as to prevent infectious complications and spread of the agent within a susceptible population, minimization of loss of patients to follow-up, and minimization of exposure to unnecessary antibiotics. The Strep A OIA helps to achieve all of these goals. The use of the test promoted a more considered use of antibiotics and eliminated the need for follow-up for a high percentage of patients. In both the WIC and PED practices, the Strep A OIA result reduced the number of patients receiving delayed therapy, the number of patients potentially lost to follow-up, and the number of patients receiving unnecessary antibiotic therapy.

The physicians participating in this study used a common approach to managing patients with pharyngitis. The certainty with which the physician approached his or her presumptive diagnosis can be evaluated through the planned therapeutic strategy. When a high degree of certainty existed, the physicians planned to prescribe either a full course of therapy for presumed group A streptococcal pharyngitis or no therapy for

TABLE 6. Summary of potentially adverse outcomes possible using one of three tactics in selecting a therapeutic strategy for patients with pharyngitis

Patient group and potentially adverse outcome	No. of patients					
	WIC patients			PED patients		
	Clinical assessment	Clinical assessment + Strep A OIA	Strep A OIA alone	Clinical assessment	Clinical assessment + Strep A OIA	Strep A OIA alone
Patients potentially lost for follow-up	15	5	4	56	9	11
Receiving 2 to 3 days of antibiotic	7	0	0	16	0	0
Receiving no antibiotic	8	5	4	40	9	11
Prescription of unnecessary antibiotics, risk for adverse drug reaction	58	41 (23 <sup>a</sup> )	2	43	36 (23 <sup>a</sup> )	7

<sup>a</sup> Number of patients after adjustment for confounding diagnoses.

patients lacking the classic clinical symptoms of group A streptococcal pharyngitis. When they were relatively uncertain, the physicians planned to prescribe a 2- to 3-day course of therapy targeted to group A streptococcal pharyngitis. Therapeutic accuracy based on clinical impression alone was, consequently, somewhat less than clinical accuracy. Each physician was willing to acknowledge limitations in clinical judgment. Yet all members of both groups used empirical therapy even with the knowledge that essentially all patients seen in this population would receive adequate follow-up.

Given a less reliable patient population, the use of a test with this degree of accuracy becomes increasingly attractive, allowing close to 95% of patients to be treated appropriately based on the test result alone at the time of their visit. We should also note that we conducted this evaluation under ideal analytical and postanalytical conditions. We optimized the accuracy of the Strep A OIA by having a laboratory technologist perform the test, and we immediately reported the results to the physician while the patient was still available. These conditions are critical for producing the desired outcomes, and in many environments, they may be difficult to achieve.

It is important that reliance on the Strep A OIA result alone dramatically improved the use of antibiotic therapy. Although a small number of patients for whom group A streptococci were recovered in culture would not have received adequate therapy, the reduction in the use of unneeded antibiotics could have been dramatic. The number of patients potentially lost to follow-up without the Strep A OIA would have significantly exceeded the number lost to follow-up due to false-negative test results. Similarly, the number of patients placed at risk for an unnecessary adverse antibiotic reaction without the Strep A OIA would have significantly exceeded the number occasioned by the number treated due to false-positive test results.

We conclude that the use of a highly sensitive assay such as the Strep A OIA improves the outcome when managing patients with symptoms of pharyngitis. We further conclude that neither clinical assessment nor culture adds significantly to the improved outcome and that the preferred strategy entails exclusive reliance on a test with features equivalent to those of the BioStar Strep A OIA.

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