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Group A streptococcal infection in patients presenting with a sore throat at an accident and emergency department: prospective observational study

在急症室出現喉嚨痛患者的A組鏈球菌感染：預期觀察研究

Objectives. To determine the prevalence of group A streptococcal infection and to evaluate the predictive value of clinical findings and rapid streptococcal antigen detection testing in patients presenting with a sore throat or suspected clinically to have acute pharyngitis.
Design. Prospective observational study.
Setting. Accident and emergency department of a public hospital, Hong Kong.
Patients. All patients presenting with a sore throat as the chief complaint, or suspected clinically to have acute pharyngitis, from April to September 2000.
Main outcome measures. Demographic data, clinical features, microbiological throat culture results, and rapid streptococcal antigen detection (Accustrip) test results.
Results. Of 1449 patients recruited during the 6-month study period, only 44 (3.0%) had positive throat cultures for group A beta-haemolytic streptococcus. The majority of group A beta-haemolytic streptococci were isolated from patients between the age of 3 and 60 years. Clinical findings other than an absence of cough were found to be unhelpful in predicting group A beta-haemolytic streptococcal throat infection. The sensitivity of the rapid group A streptococcal antigen detection test was 52.6% and the specificity was 98.2%.
Conclusions. The prevalence of group A beta-haemolytic streptococcus in patients presenting with a sore throat, or suspected clinically of having acute pharyngitis, was low. If empirical antibiotics were given to all such patients, 97% of them would be unnecessarily treated. Age and absence of cough were the only clinical findings helpful in predicting the presence of group A beta-haemolytic streptococcal throat infection. The rapid group A streptococcal antigen detection test can provide a quick guide to clinicians on the necessity of antibiotic therapy. However, a confirmatory throat culture backup is recommended for patients with a negative test result.

目的：確定A組鏈球菌感染的流行狀況，評價臨床發現和在喉嚨痛或懷疑有急性咽炎的患者中進行快速鏈球菌抗原檢測的預期價值。
設計：預期觀察研究。
安排：香港一所公立醫院的急症室。
患者：從2000年4月至9月，主訴有喉嚨痛或臨床懷疑有急性咽炎的所有患者。
主要結果測量：人口統計學數據、臨床特徵、微生物的喉嚨培養結果、以及快速鏈球菌抗原檢測(Accustrip)檢驗結果。
結果：在六個月研究期間調查的1449名患者中，只有44名(3.0%)出現陽性A組β溶血鏈球菌咽喉培養物。大多數A組β溶血鏈球菌是從3至60歲的患者中分離出的。除了沒有咳嗽外的臨床發現對預報A組β溶血鏈球菌咽喉感染並無效用。快速A組鏈球菌抗原檢驗的靈敏度為52.6%，唯一性為98.2%。
結論：在有喉嚨痛或臨床懷疑有急性咽炎的患者中，A組β溶血鏈球菌流行率較低。如果給所有這樣的患者服用治療鏈球菌的抗生素，則有97%患者並無必要接受這種治療。年齡和沒有咳嗽是有助於預示A組β溶血鏈球菌咽喉感染存在的唯一臨床發現。快速A組鏈球菌抗原檢驗可為臨床醫生提供抗生素治療必要性的快速指導。然而，對於檢測結果呈陰性的患者，建議以確定的喉嚨培養物作診斷支持。

Key words:
Antigens/bacterial;
Pharyngitis;
Streptococcal infections;
Streptococcus pyogenes

關鍵詞：
抗原/細菌；
咽炎；
鏈球菌感染；
鏈球菌生膿

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Introduction

Acute sore throat or pharyngitis is one of the most common presenting problems in emergency departments[1] and primary care clinics.[2] Acute pharyngitis (inflammation of the oropharynx) usually occurs in response to colonisation by a respiratory pathogen, of which there are many examples.[3] Viruses are the most common cause of acute pharyngitis. Such sore throats accompanying a 'cold' or 'flu' usually resolve without antibiotics in 2 to 4 days.

Most common bacterial isolates (eg groups C and G beta-haemolytic streptococci) produce a self-limiting infection with no significant sequelae. However, oropharyngeal infection with group A beta-haemolytic streptococcus may have serious consequences if left untreated, eg rheumatic heart disease and glomerulonephritis. The incidence of post-streptococcal rheumatic heart disease has decreased compared with 50 years ago, although it still occurs, while that of post-streptococcal glomerulonephritis has essentially disappeared. Overall, the incidence of severe complications is low.[4]

Group A beta-haemolytic streptococcal (GABHS) infection is the most common form of acute pharyngitis for which antibiotic therapy is definitely indicated.[5] Group A beta-haemolytic streptococcal throat infection and its complications constitute a significant health problem, not only in developing countries, but also in developed countries. The prevalence of GABHS pharyngitis in Hong Kong is unclear. However, the recent resurgence of GABHS pharyngitis and its complications among middle-class North American families attests to the continued importance of this pathogen, even in more affluent populations.[6]

Unfortunately, there has been no significant change in control measures used in the past half century, with changes being confined mainly to accurate diagnosis followed by appropriate antibiotic therapy. Doctors at emergency departments or out-patient clinics always face the dilemma with patients presenting with sore throats or acute pharyngitis of whether to prescribe an antibiotic, take a throat swab, or simply offer some words of comfort. The empirical use of antibiotics has no benefit in treating non-bacterial sore throats and, moreover, exposes patients to unnecessary hazards and expenses. In addition, over-prescribing of antibiotics may subsequently lead to the emergence and spread of multiple drug-resistant bacteria. At the same time, doctors need to diagnose GABHS throat infection correctly for early treatment to begin in order to prevent complications—something that is difficult to do based on clinical grounds alone. Some authorities recommended using the Breese score as a clinical tool for the diagnosis of GABHS pharyngitis.[7] Breese,[8] Walsh et al,[9] Centor et al,[10] and Dagnelie et al[11] have demonstrated that the combination of four clinical features (fever ≥38°C, absence of cough, tonsillar exudates, and anterior cervical lymphadenopathy) is highly suggestive of GABHS pharyngitis. However, these clinical scoring systems have proven unsuccessful in other studies, with negative predictive values of 38% to 88% and positive predictive values of 39% to 59%,[12-16] and correlated poorly with microbiological data.[15,17,18]

Throat swabs, which are considered to be the gold standard for diagnosing GABHS pharyngitis, take at least 1 to 2 days for the results to become available and add to the overall expense. The demonstration of a four-fold rise in serum antistreptolysin-O titre may indicate recent infection with group A beta-haemolytic streptococcus. However, serum antistreptolysin-O titre measurement is not practical in the acute management of throat infections. In this respect, the rapid group A streptococcal antigen detection test (RAT) may have a role in confirming the diagnosis of group A streptococcal pharyngitis. The sensitivity of RAT measured against throat swab culture varies between 61% and 95%, whereas its specificity varies between 88% and 100%.[7]

In Hong Kong, management strategies for patients with sore throat or acute pharyngitis vary significantly among clinicians. A study of the local prevalence of GABHS throat infection, together with the predictive values of clinical findings and RAT, would facilitate the construction of a systematic management protocol for patients presenting with an acute sore throat.

Methods

This study was conducted over a 6-month period from 1 April to 30 September 2000 in the Accident and Emergency (A&E) Department of North District Hospital—a district general hospital serving a population of about 270 000. All patients who presented to the A&E Department with a sore throat as their chief complaint, which was suspected to be infective in origin, were recruited into the study. The study was approved by the Ethics Committee of the hospital.

After consultation, the attending doctors completed a data sheet for every recruited patient, which recorded information including age, sex, body temperature, duration of sore throat, rhinorrhoea, cough, pharyngeal erythema, tonsillar exudates, anterior cervical lymphadenopathy, scarlatiniform rash, peritonsillar cellulitis or abscess, and antibiotic treatment in the preceding 14 days. Patients who presented with a sore throat after vomiting, prolonged cough, and foreign body or corrosive fluid ingestion were excluded. As the management of peritonsillar cellulitis or abscess necessitated intravenous antibiotics, this group of patients was subsequently excluded from further analysis. In addition, patients whose complaints were essentially a common cold or influenza, or who had taken antibiotic treatment in the preceding 14 days, were excluded. Each patient was entered once only for similar symptoms, regardless of the number of attendances.

If, after consultation and recruitment, antibiotic treatment was clinically indicated in a patient on account of suspected

GABHS throat infection, two pharyngeal swabs were taken. These were obtained by firmly swabbing the tonsillar crypts bilaterally and the posterior pharyngeal wall with a cotton-capped swab. One of the swabs was then sent to the microbiology laboratory for culture. Briefly, the swabs were inoculated on 5% horse blood agar and incubated aerobically for 48 hours. Beta-haemolytic colonies with streptococcal morphological features were sero-grouped by the latex agglutination test. The Kirby-Bauer test was used to determine the sensitivity of beta-haemolytic streptococci to penicillin, erythromycin, and trimethoprim/sulfamethoxazole.

The other throat swabs were used for RAT, ie the detection of GABHS antigen by enzyme-linked immunoassay (Accustrip, Jant Pharmacal Corporation, US). The test consisted of a membrane strip, which was precoated with rabbit antistreptococcal A antibody on the test band region and goat antirabbit antistreptococcal A antibody on the control band zone. The swabs were first put into the extraction reagents, followed by the test strips. Test results were available within 10 minutes. The sensitivity and specificity quoted by the manufacturer were 94.8% and 96.2%, respectively. The positive predictive value claimed was 90.2% and the negative predictive value was 98.1%. However, there was a detection limit of 2.5×10^5 organisms per test.

The RAT result was recorded on the patient's data sheet and used to guide antibiotic therapy as follows:

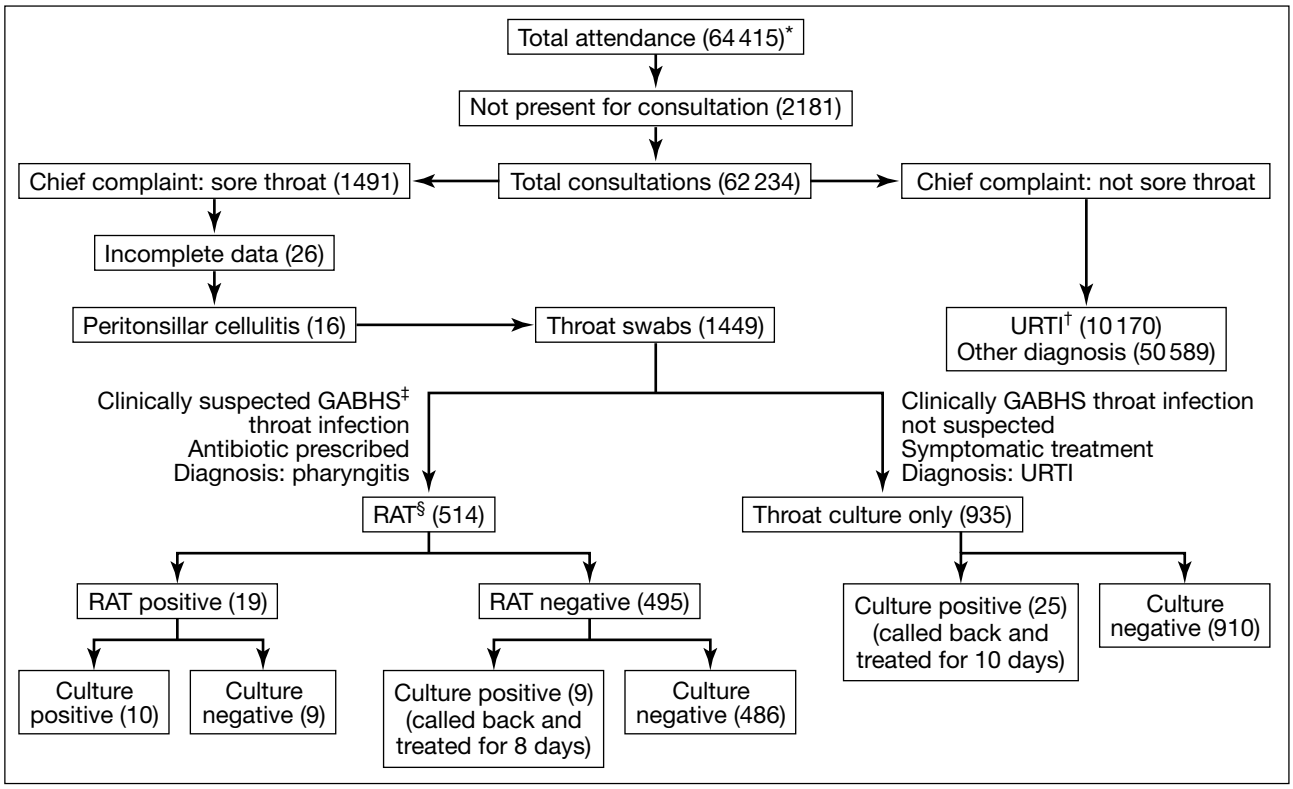
- Patients with a positive RAT result were prescribed a standard 10-day course of antibiotic therapy (penicillin V 500 mg four times daily in adults or 10 mg/kg four times daily in children)[4,19];
- Patients with a negative RAT result were given 2 days of antibiotic therapy. If the culture results were positive, they were called back and given oral penicillin V for a further 8 days[20-23]; and
- For patients hypersensitive to penicillin, erythromycin (500 mg twice daily in adults and 15 mg/kg up to 500 mg/kg three times daily in children) was used.

If antibiotic treatment was not clinically indicated, RAT was not performed and a throat swab was taken for culture only. These patients were given symptomatic treatment without antibiotic therapy, while waiting for the culture result.

In terms of diagnostic value, the clinical findings were compared with the culture results using Chi squared analysis and Fisher's exact test. Statistical significance was assumed for $P<0.05$. The diagnostic value of RAT in GABHS pharyngitis was also evaluated.

Results

During the 6-month study period, 1491 patients were recruited into the study. Of these, 26 were excluded because of incomplete data from the data sheet or culture. A further 16 who were suffering from peritonsillar cellulitis or abscess were also excluded (Fig). Of the remaining 1449 patients, 776 were male and 673 were female (male:female=1.15:1).



* No. of patients are shown in brackets
† URTI upper respiratory tract infection
‡ GABHS group A beta-haemolytic streptococcal
§ RAT rapid group A streptococcal antigen detection test

Fig. Schematic diagram of group A beta-haemolytic streptococcal pharyngitis study

Table 1. Microbiological findings in patients presenting with a sore throat

Bacterial pathogen	Patients No. (%)
Commensals	1294 (89.3)
Beta-haemolytic streptococcus	
Group A	44 (3.0)
Group C	5 (0.3)
Group G	38 (2.6)
No growth	68 (4.7)
Total	1449 (100)

Table 2. Antibiotic sensitivity testing of beta-haemolytic streptococci

Beta-haemolytic streptococcus	Antibiotics		
	Penicillin	Erythromycin	Trimethoprim/ sulfamethoxazole
Group A	100%	65.9%	91.0%
Group C	100%	80.0%	100%
Group G	100%	65.8%	94.7%

Microbiological culture

The throat culture results are shown in Table 1. Group A beta-haemolytic streptococcus was isolated in only 3.0% of the cultures. All GABHS isolates were susceptible to penicillin, 91% to trimethoprim/sulfamethoxazole, and 65.9% to erythromycin (Table 2).

All group C beta-haemolytic streptococcal isolates were sensitive to penicillin and trimethoprim/sulfamethoxazole, and only one strain was resistant to erythromycin. All group G beta-haemolytic streptococcal (GGBHS) isolates were susceptible to penicillin, 94.7% to trimethoprim/sulfamethoxazole, and 65.8% to erythromycin.

Age factor

Patients' ages ranged from 6 months to 94 years (mean, 17.8 years). Group A beta-haemolytic streptococcus was isolated from one patient aged 3 years; without exception all other patients in whom this organism was detected were older than 3 years. Children with GABHS pharyngitis were, on average, younger than those with non-GABHS pharyngitis.

The rapid group A streptococcal antigen detection test findings

The RAT was positive in 19 out of 514 tests (Table 3). The sensitivity of the Accustrip was 52.6% and the specificity was 98.2%. The positive and negative predictive values of the Accustrip were also 52.6% and 98.2%, respectively. The likelihood ratio for a positive test was 28.9 and for a negative test it was 0.48.

Table 3. Rapid streptococcal antigen detection (Accustrip) test versus throat culture result for group A beta-haemolytic streptococcus

Accustrip result	Throat culture result		
	Positive	Negative	Total
Positive	10	9	19
Negative	9	486	495
Total	19	495	514

Clinical features

In this study population, cough (67.9%) was more often associated with growth of commensals than group A beta-haemolytic streptococcus in throat culture. Conversely, the absence of cough was significantly associated with GABHS pharyngitis ($P<0.01$).

There was no statistically significant association between fever ≥38°C or rhinorrhoea and positive culture of group A beta-haemolytic streptococcus. Of the 240 (16.6%) patients with tonsillar exudates, only 10 (4.2%) had GABHS infection. Another 10 had GGBHS infection. Most patients with positive cultures of group A beta-haemolytic streptococcus did not have tonsillar exudates (77.3%) or anterior cervical lymphadenopathy (70.5%).

Clinical findings in patients with a sore throat were compared with the presence of group A beta-haemolytic streptococcus in culture (Table 4). Pharyngeal erythema was found in most patients with documented GABHS throat infection (90.9%). However, while this symptom had a high sensitivity for GABHS throat infection, it had a low specificity (16.2%). Overall, pharyngeal erythema was commonly associated with a sore throat, irrespective of the presence of group A beta-haemolytic streptococcus.

Scarlatiniform rash was not commonly seen in patients with a sore throat, although it had a high specificity for GABHS throat infection (98.4%). Unfortunately, even in patients with all four of the highly suggestive clinical features (ie fever ≥38°C, absence of cough, tonsillar exudates, and anterior cervical lymphadenopathy), the corresponding positive predictive value was only 41.1 (data not shown).

The sensitivity and specificity of the clinical judgement for starting antibiotic treatment (ie clinical suspicion of GABHS throat infection) were 43.2% and 64.8%, respectively. The likelihood ratio for a positive decision was 1.23 and for a negative decision it was 0.88 (Table 5).

Discussion

This study included the largest sample of 'sore throat' subjects in Hong Kong to date, with patients ranging in age from 6 months to 94 years. Group A beta-haemolytic streptococcal culture was positive in only 3.0% of all recruited patients and in 4.2% of patients with tonsillar exudates.

The prevalence of GABHS throat infection in patients above the age of 14 years was 2.65%. This is a low rate compared with figures from Scandinavia and the US. In Scandinavia, most studies have shown group A beta-haemolytic streptococci to be present in about 30% of adult patients presenting with an acute sore throat.[11,24] In the US, the prevalence of GABHS infection in adult patients varies from 10 to 15%.[7,9,24]

Table 4. Predictive value of clinical findings for group A and non–group A beta-haemolytic streptococci

Clinical finding	Status	No. of patients	Patients with GABHS* infection No. (%)	Patients with non-GABHS infection No. (%)
Fever >38°C	Present	705	21 (47.7†)	684 (48.7)
	Absent	744	23 (52.3)	721 (51.3‡)
Cough	Present	984	20 (45.5†)	964 (68.6)
	Absent	465	24 (54.5)	441 (31.4‡)
Rhinorrhoea	Present	722	14 (31.8†)	708 (50.4)
	Absent	727	30 (68.2)	697 (49.6‡)
Pharyngeal erythema	Present	1218	40 (90.9†)	1178 (83.8)
	Absent	231	4 (9.1)	227 (16.2‡)
Tonsillar exudates	Present	240	10 (22.7†)	230 (16.4)
	Absent	1209	34 (77.3)	1175 (83.6‡)
Lymphadenopathy	Present	286	13 (29.5†)	273 (19.4)
	Absent	1163	31 (70.5)	1132 (80.6‡)
Scarlatiniform rash	Present	26	3 (6.8†)	23 (1.6)
	Absent	1423	41 (93.2)	1382 (98.4‡)

* GABHS group A beta-haemolytic streptococcal
† sensitivity
‡ specificity

Table 5. Clinical judgement* for starting antibiotic treatment versus throat culture result for group A beta-haemolytic streptococcus

Antibiotic treatment	Throat culture result		
	Positive	Negative	Total
Clinically indicated	19	495	514
Not clinically indicated	25	910	935
Total	44	1405	1449

* Clinical diagnosis of group A beta-haemolytic streptococcal infection

In paediatric patients (age range, 0-14 years), the overall prevalence of GABHS throat infection in Scandinavia and the US is approximately 35 to 50%.[7,25-27] In this study, the prevalence of GABHS throat infection in this age group was 38.6%, ie a much closer agreement than for patients older than 14 years. This comes as no surprise, since children are more susceptible to GABHS throat infection in all countries. In fact, group A beta-haemolytic streptococcus was rarely isolated from patients at either extreme of the age spectrum in this study. Thus, none of the children under the age of 3 years had GABHS throat infection and there was only one case of GABHS pharyngitis in patients above the age of 60 years. Overall, our findings concur with the view of Wannamaker,[28] who stated that GABHS pharyngitis is primarily a disease of children between the ages of 5 and 15 years.

Viral infection is the most common cause of acute pharyngitis in adult and paediatric patients. Indeed, for children under the age of 3 years, pharyngitis is almost always viral in nature (although it is possible that they are less able to present symptoms of bacterial infection).[20,29,30] Adenovirus is the most common cause of non-streptococcal tonsillitis followed by Epstein-Barr virus.[20,31] However, we did not perform any viral studies, as they would not have materially altered the management of such cases. In this study population, commensals were found to be the most common growth in throat cultures of patients with pharyngitis (89.3%). The prevalence of the relatively benign groups C and G beta-haemolytic streptococci was, like that of group A beta-haemolytic streptococci, 3.0%. Although *Mycoplasma pneumoniae* isolation was not attempted in this study, the role of this micro-organism in acute febrile tonsillitis is well known. In the study reported by Komaroff et al,[32] for example, *M pneumoniae* was as frequent a cause of pharyngitis in adults as was group A beta-haemolytic streptococcus.

We found that GABHS isolates remained exquisitely sensitive to penicillin in vitro in Hong Kong. Although the minimum inhibitory concentration of group A beta-haemolytic streptococci to penicillin was not determined, it may well be on the increase due to the overuse of antibiotics in our locality, in much the same way that penicillin resistance in *Streptococcus pneumoniae* has emerged as a major problem in Hong Kong.[33] For this reason, we decided it was not reasonable to use broad-spectrum antibiotics, eg amoxycillin, amoxycillin-clavulanate, ampicillin sodium/sulbactam sodium, as first-line antibiotic therapy for GABHS pharyngitis. It was alarming to find that 9.0% of GABHS strains were resistant to trimethoprim/sulfamethoxazole and 34.1% were resistant to erythromycin. By comparison, only 3.7% of GABHS strains in Sweden were resistant to erythromycin in 1999.[34] This apparent increase in erythromycin resistance might not only be a problem for patients with penicillin hypersensitivity, but also a general sign indicating that GABHS throat infection is becoming more resistant to antibiotics. First or second generation cephalosporins can be used for penicillin-allergic patients who do not manifest immediate hypersensitivity to beta-lactam antibiotics.[4] In the case of treatment failure with penicillin, cephalosporins or azithromycin can be used as second-line therapy.[35]

In agreement with previous studies, clinical findings alone were not very helpful in diagnosing GABHS throat infection.[3,20] Classical streptococcal pharyngitis is characterised by intense tonsillopharyngeal erythema, yellow tonsillar exudates, and tender or enlarged anterior cervical lymphadenopathy. Fever ≥38°C and absence of cough are also helpful indicators. This notwithstanding, the sensitivity and specificity of these clinical findings and their predictive value for a positive throat culture of group A beta-haemolytic

streptococcus are disappointing.[10,22] Sensitivity and specificity studies in countries where there is a high prevalence of GABHS throat infection suggest that sole reliance on clinical diagnosis will miss 25% to 50% of cases.[36] With the low prevalence of GABHS throat infection in Hong Kong, the chance of identifying GABHS pharyngitis will be only 41.1%, even if a patient has all four of the highly suggestive clinical features (ie fever ≥38°C, absence of cough, tonsillar exudates, and anterior cervical lymphadenopathy).

Acute exudative tonsillitis was not commonly due to GABHS infection in this study. In fact, none of the clinical findings were predictive of a positive throat culture result. Thus, there were no statistically significant differences in the incidences of fever ≥38°C, pharyngeal erythema, tonsillar exudates, and anterior cervical lymphadenopathy between patients with positive cultures of group A beta-haemolytic streptococci and those with commensal growth in this study. These findings contrast with the results of previous studies reported by Breese[8] and Centor et al.[10] That the sensitivity of an isolated clinical finding and the predictive value of that finding for a positive throat culture result were disappointing might reflect the low prevalence of GABHS throat infection in our study population. Nonetheless, the clinical implication is clear: physicians in Hong Kong may find it difficult to diagnose streptococcal pharyngitis accurately if they rely solely on clinical findings.

The observed high specificity of RAT might also reflect the low prevalence of GABHS throat infection in our population. On the other hand, we found the sensitivity of RAT to be much less than that claimed by the manufacturer. One of the limitations of this study that could have accounted for the observed low sensitivity was the reliance on culture results as being the gold standard for the diagnosis of GABHS throat infection. Even though we gave briefing sessions to all medical and nursing staff in our department, stressing the proper way and sites for taking throat swabs, interobserver bias could not be eliminated. Moreover, studies have shown that the false negative rate of throat cultures is approximately 10% even when performed accurately.[37,38] Due to financial and administrative constraints in the emergency department setting, performing blood tests at intervals to check for a rise in antistreptolysin-O titres was impractical. Similarly, there were difficulties in setting up a control group of patients to determine the carrier rate of group A streptococci in the general population.

Physicians tend to overdiagnose streptococcal tonsillopharyngitis and this may invariably lead to unnecessary treatment with antibiotics. Observations in this and previous studies[21,29] suggest that RAT for GABHS throat infection can provide a quick guide to clinicians to judge the necessity of antimicrobial therapy. However, the available RATs have varying sensitivities of 52.6% to 95% and specificities of 88% to 100%. This means that 10% to 47.4% of patients with GABHS throat infection will have a negative RAT result and hence be incorrectly diagnosed (if there is no confirmatory culture to follow). Both the American Heart Association and Infectious Diseases Society recommend that clinicians start antibiotic treatment in patients with positive RAT results, as well as in patients with negative RAT results, but positive confirmatory culture results.[4,19] When there is any clinical or epidemiological evidence that results in a high index of suspicion, patients with positive RAT results, but without confirmatory culture results, may be treated with antibiotics for GABHS throat infection. However, patients with negative RAT results should have a confirmatory culture to follow, especially in areas where there is a low prevalence of GABHS throat infection. Patients with positive RAT results should be given a standard 10-day course of penicillin, whereas patients with negative RAT results should be treated with a 2-day course of penicillin initially while awaiting the confirmatory culture results. If the culture results are positive, those patients can be called back and given oral penicillin for another 8 days.

Given the large number of patients presenting with a sore throat, systematic use of RAT will result in increased expenses. On the other hand, indiscriminate prescription of antibiotics unnecessarily exposes patients to the risks of adverse or allergic reactions and promotes resistant organisms. There is no evidence of an increased incidence of rheumatic heart disease when antibiotic treatment is delayed by 48 to 72 hours. Thus, in view of the low prevalence of GABHS infection in patients presenting with a sore throat plus the suboptimal sensitivity and specificity of RAT that necessitates backup cultures, microbiological culture and initial symptomatic treatment appears to be the most cost-efficient compromise. Adding RAT substantially increases expenses without materially affecting treatment outcomes.

Conclusion

Group A beta-haemolytic streptococcal pharyngitis cannot be accurately identified by clinical features alone, so throat swabs for culture are highly recommended in patients presenting with a sore throat as their chief complaint, or suspected of having acute pharyngitis, in the A&E department setting. If RAT is available, it can act as a quick guide for clinicians to judge the necessity of antibiotics. However, the RAT sensitivity in this study was disappointing. Empirical antibiotic treatment for a sore throat is not indicated and is a bad clinical practice. Routine throat cultures do increase costs, but save 97% of patients from unnecessary exposure to the side-effects of penicillin and decrease the risk of inducing antibiotic resistance. Penicillin remains the drug of first choice for GABHS pharyngitis, as it is highly effective and also helps minimise the emergence of antibiotic resistance.

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