A clinical score to reduce unnecessary antibiotic use in patients with sore throat

Education

Éducation

Warren J. McIsaac,*† MD, MSc; David White,* MD; David Tannenbaum,* MD; Donald E. Low,‡ MD

From *the Mount Sinai Family Medical Centre, Department of Family and Community Medicine, University of Toronto, Toronto, Ont., †the Institute for Clinical Evaluative Sciences in Ontario, North York, Ont., and ‡the Canadian Bacterial Diseases Network, Mount Sinai and Princess Margaret hospitals, University of Toronto, Toronto, Ont.

This article has been peer reviewed.

Can Med Assoc J 1998;158:75-83

Abstract

Objective: To validate a score based on clinical symptoms and signs for the identification of group A *Streptococcus* (GAS) infection in general practice patients with sore throat.

Design: A single throat swab was used as the gold standard for diagnosing GAS infection. Clinical information was recorded by experienced family physicians on standardized encounter forms. Score criteria were identified by means of logistic regression modelling of data from patients enrolled in the first half of the study. The score was then validated among the remaining patients.

Setting: University-affiliated family medicine centre in Toronto.

Patients: A total of 521 patients aged 3 to 76 years presenting with a new upper respiratory tract infection from December 1995 to February 1997.

Outcome measures: Sensitivity, specificity and likelihood ratios for identification of GAS infection with the score approach compared with throat culture. Proportion of patients prescribed antibiotics, throat culture use, and sensitivity and specificity with usual physician care and with score-based recommendations were compared.

Results: A score was developed ranging in value from 0 to 4. The sensitivity of the score for identifying GAS infection was 83.1%, compared with 69.4% for usual physician care ($p = 0.06$); the specificity values of the 2 approaches were similar. Among patients aged 3 to 14 years, the sensitivity of the score approach was higher than that of usual physician care (96.9% v. 70.6%) ($p < 0.05$). The proportion of patients receiving initial antibiotic prescriptions would have been reduced 48% by following score-based recommendations compared with observed physician prescribing ($p < 0.001$), without any increase in throat culture use.

Conclusions: An age-appropriate sore throat score identified GAS infection in children and adults with sore throat better than usual care by family physicians, with significant reductions in unnecessary prescribing of antibiotics. A randomized trial comparing the 2 approaches is recommended to determine the ability of the score approach to reduce unnecessary prescribing of antibiotics during routine clinical encounters.

Résumé

Objectif : Valider un résultat fondé sur des symptômes et des signes cliniques en ce qui concerne l'identification d'une infection à streptocoque du groupe A chez des patients qui consultent un omnipraticien pour un mal de gorge.

Conception : On a utilisé un seul écouvillonnage de la gorge comme étalon-or pour diagnostiquer une infection à streptocoque du groupe A. Des médecins de famille chevronnés ont consigné l'information clinique sur des formules de consultation normalisées. On a établi les critères relatifs au résultat au moyen d'une modélisation de régression logistique de données provenant de patients inscrits au cours de la première moitié de l'étude. On a ensuite validé le résultat chez les patients restants.

Contexte : Centre de médecine familiale affilié à une université à Toronto.

Patients : Au total, 521 patients âgés de 3 à 76 ans qui se sont présentés avec une nouvelle infection des voies respiratoires supérieures de décembre 1995 à février 1997.

Mesures de résultats : Sensibilité, spécificité et ratios de vraisemblance de l'identification d'une infection à streptocoque du groupe A au moyen de la méthode du résultat comparativement à l'utilisation d'une culture prélevée dans la gorge. Proportion des patients auxquels on a prescrit des antibiotiques, utilisation de la culture prélevée dans la gorge et sensibilité et spécificité des soins habituels des médecins et des recommandations fondées sur le résultat.

Résultats : On a établi une échelle de résultats variant de 0 à 4. La sensibilité du résultat pour identifier une infection à streptocoque du groupe A s'est établie à 83,1 %, comparativement à 69,4 % dans le cas des soins habituels de médecins (p = 0,06). Les deux méthodes avaient une spécificité semblable. Chez les patients âgés de 3 à 14 ans, la méthode du résultat s'est révélée plus sensible que les soins habituels du médecin (96,9 % c. 70,6 %) ($p < 0,05$). La proportion des patients qui ont reçu une première ordonnance d'antibiotique aurait diminué de 48 % si l'on avait suivi les recommandations fondées sur le résultat plutôt que les observations du médecin ($p < 0,001$), sans augmenter l'utilisation des cultures prélevées dans la gorge.

Conclusions : Un résultat relatif au mal de gorge selon l'âge a permis d'identifier une infection à streptocoque du groupe A chez les enfants et les adultes qui avaient mal à la gorge mieux que les soins habituels de médecins de famille et a réduit considérablement la prescription inutile d'antibiotiques. On recommande de procéder à une étude randomisée pour comparer les deux méthodes afin de déterminer dans quelle mesure la méthode du résultat peut réduire la prescription inutile d'antibiotiques au cours de consultations cliniques de routine.

Antibiotic resistance is emerging as an important public health issue,[1–3] and overuse of antibiotics by physicians has been implicated as contributing to the problem.[3,4] In Canada 40% of the population is estimated to receive at least one antibiotic prescription per year.[5] One of the most common reasons for visiting a family physician and receiving an antibiotic is an upper respiratory tract infection (URTI). URTI accounted for 13% of visits to Ontario general practitioners in 1989, and a prescription was given in 50% of cases.[6]

Sore throat is a common complaint in URTI and may indicate infection with group A *Streptococcus* (GAS).[7] Although GAS infection is considered an appropriate indication for antibiotic therapy,[8,9] only 10% to 20% of sore throat presentations in general practice are culture positive for GAS.[10–12] The remainder are predominantly viral. Reports from various countries estimate that an antibiotic is prescribed in 30% to 75% of visits.[13–16] This suggests that antibiotics are prescribed more often than necessary.

One reason for overuse of antibiotics may be current approaches to managing sore throat. Family physicians decide selectively whether to obtain a throat swab, prescribe an antibiotic or do neither in cases of URTI with sore throat.[17–19] Studies comparing clinical diagnosis with throat culture have shown a sensitivity of 50% to 70% and a specificity of 60% to 80%.[10–12,20] Thus, clinical judgement may miss up to 50% of GAS infections while identifying 20% to 40% of the large number of non-GAS sore throat presentations as needing antibiotics.

Clinical prediction rules have been proposed as a way to increase the accuracy of clinical diagnosis.[21] Some have been shown to improve patient outcomes in selected clinical problems.[22,23] Although several scores have been proposed for assessing patients with sore throat,[12,24–28] most were not developed in general practice settings,[12,24,25,28] and those that were have had limited evaluation.[21,26,27] Others are limited to adults[12,24] or children.[25,28] None has been shown to reduce antibiotic prescribing levels in actual clinical practice.[29]

For an approach to the management of sore throat to be of practical use during routine office visits in general practice, it should be simple, be applicable to children and adults, assist in reducing unnecessary prescribing of antibiotics and improve identification of GAS infection. We describe the development and validation of a clinical score in a group of children and adults with sore throat attending a family medicine clinic and compare score-based recommendations for antibiotic prescribing with decisions by experienced family physicians.

Methods

The study was conducted in the Family Medicine Centre at Mount Sinai Hospital, Toronto, from December 1995 to February 1997. The centre is a family medicine residency training site affiliated with the University of Toronto and handles approximately 30 000 outpatient primary care visits per year. The medical staff comprises 8 full-time family physicians, 5 part-time community-based physicians and 18 residents. All medical staff enrolled patients. The study was approved by an ethics review committee of the University of Toronto.

Patients aged 3 years or more were eligible for the study if, in the opinion of the physician, they had a new URTI. Patients were excluded if they had been taking antibiotics in the previous week or were immunocompromised. Patients or parents (in the case of children aged 16 years or less) were approached by the treating physician, and those giving written consent were enrolled. A standardized encounter form was completed by each physician at the time they assessed a patient, and a single throat swab was obtained in the physicians' usual manner.

Specimens were plated on 5% sheep blood agar (Unipath, Nepean, Ont.) and incubated anaerobically for 48 hours. GAS was identified by means of standard techniques.[30]

The encounter form was used to document the patient's age, sex, number of days ill before the visit, presence of sore throat, runny or stuffy nose, cough, swollen neck glands, headache, general aches, rash, gastrointestinal discomfort or nausea, history of a temperature greater than 38°C and recent exposure to GAS. Physicians examined patients for the presence of a red throat, tonsillar swelling, tonsillar exudate, tender anterior cervical adenopathy, a rash typical of scarlet fever, fever (optional), abnormal tympanic membranes and lung findings. They then estimated the likelihood of GAS infection on a 10-cm scale from 0% to 100% and recorded whether an antibiotic had been prescribed. To reflect usual throat culture use, physicians were asked if they would normally have obtained a throat swab.

We used the data for patients enrolled in the first half of the study to develop the score criteria. The association of clinical findings with throat culture results was assessed with the use of a χ^2 or Fisher's exact test, and a *t*-test was used for continuous variables.[31] Characteristics significant at the $p < 0.10$ level were retained for multivariate modelling in a multiple logistic regression analysis by the method of maximum likelihood estimation with the use of Stata (release 3, Computing Resource Centre, Santa Monica, Calif.).[32] The final model included clinical findings that remained significantly associated with a positive culture result ($p < 0.05$).

The score was calculated directly for the remaining patients, and the results were compared with those for the first group of patients. We assessed score accuracy and discrimination by determining sensitivity, specificity and likelihood ratios for identifying GAS infection compared with throat culture results. We determined score reproducibility by comparing the proportion of GAS cases identified in each of the 2 patient groups, using a χ^2 or Fisher's exact test.[31] This was also done for children and adults separately.

The sensitivity and specificity of score-based recommendations and of physician management for identifying GAS infection were compared with throat culture results. Physicians were considered to have identified a culture-positive case (sensitivity) if antibiotics were prescribed or a throat swab would have been taken. GAS-negative cases were considered to have been correctly managed (specificity) if antibiotics were not prescribed initially or if a throat swab would have been obtained in cases in which an antibiotic was prescribed. The physician could then advise that treatment be stopped when a negative culture result was reported. The proportion of patients prescribed antibiotics or in whom a throat swab would have been obtained under usual physician care was compared with score-based recommendations by means of a χ^2 test.[31]

Results

A total of 584 people were enrolled, 320 (54.8%) in the first half of the study and 264 (45.2%) in the second. Of the 584, 63 (10.8%) were excluded because of a diagnosis of bronchitis (in 25 cases), otitis media (in 13), sinusitis (in 8), pneumonia (in 5) or other lower respiratory tract syndrome where the score was not applicable (in 12). The remaining 521 patients (89.2%) (aged 3 to 76 years) represented 45% of the 1168 patients seen in the clinic during the study period with a recorded diagnosis of URTI/pharyngitis (ICD-10[33] code 460) or tonsillitis (code 463). The proportion of female patients in the study population was similar to the proportion in all clinic URTI encounters (70.6% and 67.3% respectively; $p = 0.17$), as was the proportion of adults (90.0% and 78.5% respectively; $p = 0.11$).

Table 1 shows the association between throat culture results and clinical findings. The overall prevalence of GAS infection was 13.8% (72/521). Age was inversely associated with GAS infection (mean age of culture-positive and culture-negative groups 21.1 and 32.1 years respectively) ($p < 0.001$), and female patients were less likely than male patients to have a positive culture result ($p = 0.01$). Symptoms associated with a positive throat culture result were absence of cough ($p < 0.001$), tender neck glands ($p = 0.02$), history of a temperature greater than

38°C ($p < 0.001$), gastrointestinal symptoms ($p = 0.01$) and recent exposure to GAS ($p = 0.01$). Signs associated with a positive culture result were red throat ($p = 0.01$), higher temperature (mean temperature of culture-positive and culture-negative groups 37.4°C and 36.9°C respectively for 304 patients) ($p < 0.001$), tender anterior cervical adenopathy ($p < 0.001$), tonsillar swelling ($p < 0.001$), tonsillar exudate ($p < 0.001$), pharyngeal exudate ($p < 0.02$) and a rash typical of scarlet fever ($p < 0.05$).

Physicians felt that throat culture was indicated in 40% of cases and prescribed antibiotics to 20.3% of patients before the culture results were available. A prescription was more likely in cases subsequently positive for GAS (48.6%) than negative (15.6%) ($p < 0.001$). The mean physician estimate of the likelihood of GAS infection was 44.9% among patients with a positive culture result and 21.0% among those with a negative result ($p < 0.001$).

Derivation of the score and management recommendations

Clinical signs and symptoms associated with a positive culture result were entered into a backward stepwise multiple logistic regression model. Four characteristics were independently associated with being more likely to have a throat culture positive for GAS: a history of temperature or measured temperature greater than 38°C (odds ratio [OR] 2.37, 95% confidence interval [CI] 1.10 to 5.10), absence of cough (OR 2.36, 95% CI 1.09 to 5.10), tonsillar swelling (OR 4.35, 95% CI 2.02 to 9.38) and tender anterior cervical adenopathy (OR 2.81, 95% CI 1.20 to 6.60). Clinical findings were weighted equally and assigned a score of 1 point.

The prevalence of GAS infection was 36.2% (34/94) among children aged 3 to 14 years and 10.7% (37/346) among those aged 15 to 44 years. GAS was isolated in

Table 1: Relation between clinical characteristics and a positive result of throat culture for group A *Streptococcus* (GAS) among patients with a new upper respiratory tract infection

Characteristic	Overall; no. (and %) of patients* *n = 521*	Culture result; % of patients* Positive *n = 72*	Negative *n = 449*
Female sex	368 (70.6)	58.3	72.8†
Ill for 1–3 d	215 (43.4)	51.4	42.1
Symptom			
Sore throat	493 (95.0)	97.2	94.6
Cough	343 (66.1)	46.5	69.2‡
Nasal symptoms	321 (61.8)	56.3	62.7
Tender neck glands	245 (47.7)	60.6	45.6†
Headache	243 (47.1)	47.9	47.0
Achiness	237 (45.9)	53.5	44.7
History of temperature > 38°C	164 (31.7)	52.8	28.3‡
Earache	171 (33.0)	34.7	32.7
Gastrointestinal symptoms	138 (26.7)	40.3	24.6†
Sinus pain	100 (19.4)	16.9	19.8
Recent exposure to GAS	61 (12.0)	21.4	10.5†
Rash	22 (4.3)	7.0	3.8
Sign			
Red throat	371 (72.6)	85.3	70.7†
Tender anterior cervical adenopathy	223 (43.8)	74.6	39.1‡
Tonsillar swelling	126 (24.6)	57.4	19.6‡
Tonsillar exudate	50 (9.8)	29.4	6.8‡
Palatal petechiae	31 (6.1)	8.8	5.7
Abnormal tympanic membrane	31 (6.1)	6.0	6.2
Pharynx exudate	15 (3.0)	7.4	2.3†
Lung findings	12 (2.4)	0.0	2.8
Scarlet fever rash	3 (0.6)	4.6	0.0†
Physician management			
Felt throat swab was indicated	204 (40.0)	60.0	36.8‡
Prescribed antibiotics	105 (20.3)	48.6	15.6‡
Estimate of GAS infection	518 (100.0)	44.9	21.0‡

*Excluding cases with missing data.
†$p < 0.05$.
‡$p < 0.001$.

1 (1.3%) of 79 adults aged 45 years or more; in 2 cases the age of the patient was missing. To adjust for age, children aged 3 to 14 years were assigned 1 point for their higher prevalence of GAS infection, those aged 15 to 44 received a score of 0, and those aged 45 or more received a score of –1. An overall score was obtained by combining the clinical score with the age score. Patients with a score lower than 0 were assigned a score of 0, and the highest score allowed was 4.

The culture results and associated likelihood ratios for the 503 patients (96.5%) with complete data are shown in Table 2. GAS was found in 2.5% of the patients with a clinical score of 0 (2.4% for patients enrolled in the first half of the study and 2.6% for those enrolled in the second half), 5.1% of those with a score of 1 (4.4%, 5.7%), 11.2% of those with a score of 2 (9.8%, 12.3%), 27.8% of those with a score of 3 (27.6%, 28.0%) and 52.8% of those with a score of 4 (38.1%, 62.5%). Patients with a score of 0 or 1 accounted for 59.2% of presentations, and those with a score of 4 accounted for 10.5%.

Management recommendations associated with the sore throat score were defined according to the probability of GAS infection (see figure). Where GAS infection was unlikely (prevalence of GAS infection 2.5% to 5.1%, likelihood ratio < 0.5), neither a throat swab nor antibiotic therapy was recommended (score 0 or 1). For an intermediate likelihood (prevalence 11.2% to 27.8%, likelihood ratio < 5.0), the recommendation was to obtain a throat swab but wait for culture results before deciding about antibiotic therapy, as in most cases the result would be negative (score 2 or 3). Where the chance of GAS infection was highest (prevalence 52.8%, likelihood ratio 6.43), therapy with penicillin (erythromycin in cases of allergy) could be started immediately if the patient was in the early stage of the illness or was clinically unwell (score 4).[35,36]

Score accuracy and comparison with physician management

The sensitivity of physician judgement for identifying culture-positive GAS infection was 69.4%, compared with 83.1% for the age-appropriate score ($p = 0.06$) (Table 3). Physicians prescribed antibiotics to 20.3% of patients, compared with 10.5% with score-based management, a reduction of 48% ($p < 0.001$). There was no difference in the use of throat swabs between the 2 approaches.

Among children aged 3 to 14 years, there was no difference between the 2 approaches in the proportion receiving antibiotics or from whom throat swabs were obtained, but significantly more cases of GAS infection would have been identified with the score approach (96.9%) than with usual physician care (70.6%) ($p < 0.05$). Physician specificity was higher, however (91.7% v. 67.2%) ($p < 0.05$). Among adults the sensitivity of physician judgement and of the score approach were similar, but both throat swab use (37.3% v. 26.4%) and antibiotic prescription (16.5% v. 3.4%) would have been reduced with the score approach ($p < 0.001$).

SORE THROAT OR STREP THROAT? Is an antibiotic required?

This practical tool will help primary care physicians decide on the management of patients presenting with upper respiratory tract infection and sore throat

Step 1

Determine the patient's total sore throat score by assigning points to the following criteria:

Criteria	Point
• Temperature > 38°C	1
• No cough	1
• Tender anterior cervical adenopathy	1
• Tonsillar swelling or exudate	1
• Age 3–14 yr	1
• Age 15–44 yr	0
• Age ≥ 45 yr	–1
TOTAL SCORE	_____

Step 2

Choose the appropriate management suggested below according to the total sore throat score:

Total score	Chance of streptococcal infection in community with usual levels of infection, %	Suggested management
0 1	2–3 4–6	No culture or antibiotic is required
2 3	10–12 27–28	Culture all; treat only if culture result is positive
4	38–63	Culture all; treat with penicillin on clinical grounds*

*If patient has high temperature or is clinically unwell, and presents early in disease course. Use erythromycin if patient is allergic to penicillin.

An earlier version of this figure appeared in *Canadian Family Physician*.[34]

Score reproducibility in different patient populations

The prevalence of GAS infection was 15.3% among patients from whom the score was developed and 10.4% among those for whom scores were calculated ($p = 0.10$) (4). The proportion of positive culture results in each score category was similar in the 2 groups. Although the prevalence of infection was higher among patients aged 3 to 14 years (35.6%) than among those aged 15 to 76 years (8.0%) ($p < 0.001$), there were no significant differences between these 2 groups in the proportion of positive culture results by score category. However, the numbers of cases of GAS infection in some score categories for younger patients were small.

Discussion

A clinical score with specific management recommendations for patients with sore throat reliably and accurately identified GAS infection compared with usual care by family physicians. The proportion of patients receiving initial antibiotic prescriptions would have been reduced by 48% with a score approach, without any change in throat culture use. This represents a clinically important reduction in unnecessary antibiotic use given concerns about the role of prescribing in the promotion of antibiotic resistance.[1–4]

Some GAS-positive cultures would have been missed with the score approach, although fewer than with usual care. Family physicians have tended to use throat cultures selectively, based on their clinical judgement.[17–19] Expert groups recommend throat culture in most patients with sore throat to identify GAS infection and prevent nonsuppurative complications.[8,9] However, although studies show that clinical judgement is less sensitive than throat culture,[10–12] rheumatic fever rates have remained low in developed countries with current clinical practices.[37] Many GAS infections are likely never treated, since fewer than 20% of people with sore throat or pharyngotonsillitis seek medical attention.[38,39] These observations suggest that some loss in diagnostic sensitivity is acceptable and is unlikely to result in increased rates of rheumatic fever.

The accuracy of clinical judgement does, however, have implications for unnecessary antibiotic use. Although the physicians in our study were able to discriminate somewhat between patients with and without GAS infection, they prescribed antibiotics to twice as many patients with a negative culture result (70) as those with a positive result (35). Since most patients with sore throat who have a URTI do not have GAS infection[10–12] (86% in our study), small errors in clinical judgement result in large numbers of unnecessary prescriptions.

Although the specificity of clinical judgement in our study was higher than in other reports,[10–12,16] we used a definition that assumed that physicians would advise patients with a negative culture result to stop antibiotic therapy. Surveys show that up to half of physicians would not necessarily stop treatment when faced with a negative culture report.[17–19] It is also unclear whether patients would comply and stop therapy after they have paid for medication. Thus, any reduction in unnecessary antibiotic use is most likely to come from affecting initial prescribing decisions.

Although additional prescriptions are needed for patients advised only to have a throat swab (score 2 or 3) and found to harbour GAS, this is also true of usual physician management. The antibiotic prescribing rate by physicians after all culture results were known would have been 23% if antibiotic therapy had not been stopped in any patient, compared with 16% with the score approach. This latter figure is similar to the observed prevalence of GAS infection of 14%. Given variations in physician prescribing,[13–16] the score approach may offer more consistent matching of antibiotic prescribing to prevalence of GAS infection.

The score approach identified more cases of GAS infection than usual care in children but not in adults. Conversely, throat swab use and antibiotic prescriptions were reduced in adults but not in children. These differences might suggest that different approaches are needed for the 2 groups. However, the higher prevalence of infection and risk of nonsuppurative complications in children make GAS infection case-finding an important consideration in this group.[8,9,40] This may be less of a concern in adults, in whom the disease remains uncommon,[37,41,42] although sporadic outbreaks of rheumatic fever have been reported.[43] Moreover, for busy clinicians the practical benefits of a single approach likely outweigh any additional gains that might be possible with 2 separate approaches.

In addition to being applicable to both children and adults, there are other differences between this score and previously proposed prediction rules for sore throat.[12,24–28] First, it has been developed in general practice with pa-

Table 2: Age-appropriate sore throat score, culture results and likelihood ratios (positive) for the 503 patients with complete data

Score	No. (and %) of patients			Likelihood ratio (positive)
	Overall	Culture result		
		Negative	Positive	
0	160 (31.8)	156 (97.5)	4 (2.5)	0.14
1	138 (27.4)	131 (94.9)	7 (5.1)	0.32
2	98 (19.5)	87 (88.8)	11 (11.2)	0.84
3	54 (10.7)	39 (72.2)	15 (27.8)	2.49
4	53 (10.5)	25 (47.2)	28 (52.8)	6.43
Total	503 (100.0)	438 (87.1)	65 (12.9)	

tients similar to those family physicians are likely to encounter. The prevalence of GAS infection in our study was similar to that observed in other general practice studies.[12–14] The prevalence of GAS infection among children attending our clinic (36.2%) was also similar to reports from pediatric clinics (40% to 48%).[28,44] The transportability of prediction rules to new settings has been shown to be primarily dependent on disease prevalence.[45] Thus, the score is likely applicable in most general practice offices. Second, validation of the score in a second group of patients showed similar levels of discrimination for GAS disease. Other rules have generally not been tested in other patient populations.[26,27] Finally, we linked probability estimates for the likelihood of GAS infection to explicit management recommendations.[34] Failure to provide advice concerning appropriate clinical actions to take in response to differing disease probabilities has been suggested as one reason why a similar score did not reduce antibiotic use in actual practice.[29]

We recognize that physicians sometimes start antibiotic therapy before culture results are known, to offer patients symptom relief.[17] However, although improved symptom relief has been reported with early antibiotic treatment in children with a high temperature,[35] the difference was found to be minimal in other patients with less severe illness.[46,47] In adults, only one study has shown improved symptom relief in those with at least 3 of the following signs: fever, anterior cervical adenopathy, tonsillar exudate and absence of cough.[36] Such adults (score 3 or 4) represented only 8% of all presentations in our study.

Table 3: Comparison of physician and score-associated management

Group; variable	Usual physician care	Age-appropriate score	*p* value*
All patients	*n = 517*†	*n = 503*	
No. of cases of GAS infection	72	65	
Sensitivity, %	69.4 (50/72)	83.1 (54/65)	0.06
Specificity, %	96.6 (430/445)	94.3 (413/438)	NS
No. (and %) in whom throat swab indicated	204 (39.4)‡	205 (40.8)	NS
No. (and %) for whom antibiotic prescribed	105 (20.3)	53 (10.5)	< 0.001
Patients aged 3–14 yr	*n = 94*	*n = 90*	
No. of cases of GAS infection	34	32	
Sensitivity, %	70.6 (24/34)	96.9 (31/32)	< 0.05
Specificity, %	91.7 (55/60)	67.2 (39/58)	< 0.05
No. (and %) in whom throat swab indicated	48 (52.2)§	43 (47.8)	NS
No. (and %) for whom antibiotic prescribed	35 (37.2)	39 (43.3)	NS
Patients aged 15–76 yr	*n = 423*	*n = 413*	
No. of cases of GAS infection	38	33	
Sensitivity, %	68.4 (26/38)	69.7 (23/33)	NS
Specificity, %	97.4 (375/385)	98.4 (374/380)	NS
No. (and %) in whom throat swab indicated	156 (37.3)‖	109 (26.4)	< 0.001
No. (and %) for whom antibiotic prescribed	70 (16.5)	14 (3.4)	< 0.001

*NS = not significant.
†Prescribing data missing in 4 cases.
‡n = 510.
§n = 92.
‖n = 418.

Table 4: Score reproducibility in different patient populations

Score	Group; % of throat cultures positive for GAS: Patients from whom score was developed *n = 262*	Group; % of throat cultures positive for GAS: Remaining patients *n = 241*	*p* value	Group; % of throat cultures positive for GAS: Patients aged 3–14 yr *n = 90*	Group; % of throat cultures positive for GAS: Patients aged 15–76 yr *n = 413*	*p* value
0	2.6 (2/76)	2.4 (2/84)	1.00*	NA†	2.5 (4/160)	–
1	4.4 (3/68)	5.7 (4/70)	1.00*	12.5 (1/8)	4.6 (6/130)	0.35*
2	12.3 (7/57)	9.8 (4/41)	0.76*	21.0 (4/19)	8.9 (7/79)	0.22*
3	27.6 (8/29)	28.0 (7/25)	0.97	29.2 (7/24)	26.7 (8/30)	0.73
4	62.5 (20/32)	38.1 (8/21)	0.08	51.3 (20/39)	57.1 (8/14)	0.71
Total	15.3 (40/262)	10.4 (25/241)	0.10	35.6 (32/90)	8.0 (33/413)	< 0.001

*Fisher's exact test.
†NA = not applicable.

Also, GAS pharyngotonsillitis is a self-limited illness in which symptoms are resolving by 3 days.[15] Fewer than half (43%) of the patients in our study presented in the first 3 days of their illness. Most would be unlikely to experience significant symptom relief from antibiotics beyond the relief that would occur as part of the natural history of the illness. Thus, antibiotics for symptom relief may be indicated when patients present early, are sick and have a high probability of GAS infection (score 4).

Our study has some limitations. First, the number of children was small. It would be prudent to validate the score in an additional group of pediatric patients and in general practice patients.[21] Second, in settings where disease prevalence is lower,[20] the score may overestimate the prevalence of GAS infection.[45,48] Similarly, the score should not be used in epidemic situations and in populations in which rheumatic fever remains a problem.[49] Finally, physicians in our study were required to document their management practices, which may have resulted in better than expected performance. However, this would tend to reduce differences between usual care and the score approach, lending strength to the finding of a significant reduction in antibiotic use.

The age-appropriate sore throat score is a simple primary care management approach that improves identification of GAS infection, limits the need for throat swabs in all patients with sore throat and can reduce unnecessary antibiotic use. Although other factors have been shown to influence physicians' prescribing decisions,[50,51] GAS infection remains the main indication for antibiotic treatment in sore throat.[8,52] A randomized trial of the score approach compared with usual clinical care is recommended[21] to determine its ability to reduce unnecessary prescribing of antibiotics during routine clinical encounters.

References

1. Neu HC. The crisis in antibiotic resistance. *Science* 1992;257:1064-73.
2. Brierman RF, Butler JC, Tenover FC, Elliot JA, Facklam RR. Emergence of drug-resistant pneumococcal infections in the United States. *JAMA* 1994; 271:1831-5.
3. Tenover FC, Hughes JM. The challenge of emerging infectious diseases. Development and spread of multiply-resistant bacterial pathogens. *JAMA* 1996;275:300-4.
4. Arason VA, Kristinsson KG, Sigurdsson JA, Stefansdottir G, Molstad S, Gudmundsson S. Do antimicrobials increase the carriage rate of penicillin resistant pneumococci in children? Cross sectional prevalence study. *BMJ* 1996;313:387-91.
5. Quinn K, Baker MJ, Evans B. A population-wide profile of prescription drug use in Saskatchewan, 1989. *Can Med Assoc J* 1992;146:2177-86.
6. Weinkauf DJ, Rowland GC. Patient conditions at the primary care level: a commentary on resource allocation. *Ont Med Rev* 1992;Jan:11-15,61.
7. Commission on Acute Respiratory Diseases. Endemic exudative pharyngitis and tonsillitis. Etiology and clinical characteristics. *JAMA* 1944;125:1161-9.
8. Infectious Diseases and Immunization Committee, Canadian Paediatric Society. Group A *Streptococcus*: a re-emergent pathogen. *Can Med Assoc J* 1993; 148:1909-11.
9. Dajani AS, Bisno AL, Chung KJ, Durack DT, Gerber MA, Kaplan EL, et al. Prevention of rheumatic fever. A statement for health professionals by the Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease of the Council on Cardiovascular Disease in the Young, the American Heart Association. *Circulation* 1988;78:1082-6.
10. Hart WJ. Streptococcal pharyngitis. A demonstration of the inaccuracy of clinical diagnosis without culture. *Can Fam Physician* 1976;22:34-9.
11. Shank JC, Powell TA. A five-year experience with throat cultures. *J Fam Pract* 1984;18:857-63.
12. Centor RM, Witherspoon JM, Dalton HP, Brody CE, Link K. The diagnosis of strep throat in adults in the emergency room. *Med Decis Making* 1981; 1:239-46.
13. Mainous AG III, Hueston WJ, Clark JR. Antibiotics and upper respiratory tract infection. Do some folks think there is a cure for the common cold? *J Fam Pract* 1996;42:357-61.
14. McGregor A, Dovey S, Tilyard M. Antibiotic use in upper respiratory tract infections in New Zealand. *Fam Pract* 1995;12:166-70.
15. Touw-Otten FWM, Staehr Johansen K. Diagnosis, antibiotic treatment and outcome of acute tonsillitis: report of a WHO regional office for Europe study in 17 European countries. *Fam Pract* 1992;9:255-67.
16. Klajokvic M. Sore throat presentation and management in general practice. *N Z Med J* 1993;106:381-3.
17. McIsaac WJ, Goel V. Sore throat management practices of Canadian family physicians. *Fam Pract* 1997;14:34-9.
18. Holmberg SD, Faich GA. Streptococcal pharyngitis and acute rheumatic fever in Rhode Island. *JAMA* 1983;250:2307-12.
19. Cochi SL, Hightower AW, Facklam RR, Broome CV. Diagnosis and treatment of streptococcal pharyngitis: survey of US medical practitioners. In: Shulman ST, editor. *Pharyngitis: management in an era of declining rheumatic fever*. New York: Praeger Publishers; 1984. p. 51-9.
20. Cebul RD, Poses RM. The comparative cost-effectiveness of statistical decision rules and experienced physicians in pharyngitis management. *JAMA* 1986;256:3353-7.
21. Wasson JH, Sox HC. Clinical prediction rules. Have they come of age? [editorial] *JAMA* 1996;275:641-2.
22. Pozen MW, D'Agostino RB, Selker HP, Sytkowski PA, Hood WB. A predictive instrument to improve coronary care unit admission practices in acute ischemic heart disease. *N Engl J Med* 1984;310:1273-8.
23. Stiell IG, McKnight RD, Greenberg GH, McDowell I, Nair RC, Wells GA, et al. Implementation of the Ottawa ankle rule. *JAMA* 1994;271:827-32.
24. Walsh BT, Bookheim WW, Tompkins RK. Recognition of streptococcal pharyngitis in adults. *Arch Intern Med* 1975;135:1493-7.
25. Breese BB. A simple scorecard for the tentative diagnosis of streptococcal pharyngitis. *Am J Dis Child* 1977;131:514-7.
26. Dobbs F. A scoring system for predicting group A streptococcal throat infection. *Br J Gen Pract* 1996;46:461-4.
27. Hoffman S. An algorithm for a selective use of throat swabs in the diagnosis of group A streptococcal pharyngo-tonsillitis in general practice. *Scand J Prim Health Care* 1992;10:295-300.
28. Fujikawa S, Ito Y. A new scoring system for diagnosis of streptopharyngitis. *Jpn Circ J* 1985;49:1258-61.
29. Poses RM, Cebul RD, Wigton RS. You can lead a horse to water — improving physicians' knowledge of probabilities may not affect their decisions. *Med Decis Making* 1995;15:65-76.
30. Facklam RR, Washington JA III. *Streptococcus* and related catalase-negative gram-positive cocci. In: Balows A, Hauser WJ Jr, Herrmann KL, Isenberg HD, Shadomy HJ, editors. *Manual of clinical microbiology*. 5th ed. Washington: American Society for Microbiology; 1991. p. 238-57.
31. Rosner B. *Fundamentals of biostatistics*. 2nd ed. Boston: PWS Publishers; 1986. p. 307-32.
32. Hosmer DW, Lemeshow S. *Applied logistic regression*. New York: John Wiley & Sons; 1989. p. 82-134.
33. World Health Organization. *International statistical classification of diseases and related health problems*. 10th rev. Geneva: The Organization; 1992.
34. McIsaac WJ, Goel V, Slaughter PM, Parsons GW, Woolnough KV, Weir PT, et al. Reconsidering sore throats. Part 2: Alternative approach and practical office tool. *Can Fam Physician* 1997;43:495-500.
35. El-Daher NT, Hijazi SS, Rawashdeh NM, al-Khalil IA, Abu-Ektaish FM, Abdel-Latif DI. Immediate vs. delayed treatment of group A beta-hemolytic streptococcal pharyngitis with penicillin V. *Pediatr Infect Dis J* 1991;10:126-30.
36. Dagnelie CF, Van Der Graaf Y, De Melker RA. Do patients with sore throat benefit from penicillin? A randomized double-blind placebo-controlled clinical trial with penicillin V in general practice. *Br J Gen Pract* 1996;46:589-93.
37. Quinn RW. Comprehensive review of morbidity and mortality trends for rheumatic fever, streptococcal disease and scarlet fever: the decline of rheumatic fever. *Rev Infect Dis* 1989;11:928-53.
38. Valkenburg HA, Haverkorn MJ, Goslings WRO, Lorrier JC, de Moor CE, Maxted WR. Streptococcal pharyngitis in the general population: 2. The attack rate of rheumatic fever and acute glomerulonephritis in patients not treated with penicillin. *J Infect Dis* 1971;124:348-58.
39. Evans CE, McFarlane AH, Norman GR, Neale KA, Streiner DL. Sore

throats in adults: Who sees a doctor? *Can Fam Physician* 1982;28:453-8.
40. Veasy LG, Tani LY, Hill HR. Persistence of acute rheumatic fever in the intermountain area of the United States. *J Pediatr* 1994;124:9-16.
41. Hutten-Czapaki P. Acute rheumatic fever — no epidemic in Ontario. *Can J Public Health* 1989;80:71-2.
42. Taubert KA, Rowley AH, Shulman ST. Nationwide survey of Kawasaki disease and acute rheumatic fever. *J Pediatr* 1991;119:279-83.
43. Wallace MR, Garst PD, Papadimos TJ, Oldfield EC. The return of acute rheumatic fever in young adults. *JAMA* 1989;262:2557-61.
44. Siegel AC, Johnson EE, Stollerman GH. Controlled studies of streptococcal pharyngitis in a pediatric population: 1. Factors related to the attack rate of rheumatic fever. *N Engl J Med* 1961;265:559-66.
45. Poses RM, Cebul RD, Collins M, Fager SS. The importance of disease prevalence in transporting clinical prediction rules. The case of streptococcal pharyngitis. *Ann Intern Med* 1986;105:586-91.
46. Pichichero ME, Disney FA, Talpey WB, Green JL, Francis AB, Roghmann KJ, et al. Adverse and beneficial effects of immediate treatment of group A beta-hemolytic streptococcal pharyngitis with penicillin. *Pediatr Infect Dis J* 1987;6:635-43.
47. Middleton DB, D'Amico F, Merenstein JH. Standardized symptomatic treatment versus penicillin as initial therapy for streptococcal pharyngitis. *J Pediatr* 1985;106:870-4.
48. Morise AP, Diamond GA, Detrano R, Bubbio M, Gunel I. The effect of disease-prevalence adjustments on the accuracy of a logistic prediction model. *Med Decis Making* 1996;16:133-42.
49. Bach JF, Chalons S, Forier E, Elana G, Jouanelle J, Kayemba S, et al. 10-year educational programme aimed at rheumatic fever in two French Caribbean islands. *Lancet* 1996;347:644-8.
50. Howie JGR. Clinical judgement and antibiotic use in general practice. *BMJ* 1976;2:1061-4.
51. Stephenson MJ, Henry N, Norman GR. Factors influencing antibiotic use in acute respiratory infections in family practice. *Can Fam Physician* 1988; 34:2149-52.
52. Cimolai N. Bacteriology of the upper respiratory tract: What is important? *Can Fam Physician* 1988;34:2155-9.

Correspondence to: *Dr. Warren J. McIsaac, Mount Sinai Family Medical Centre, 413–600 University Ave., Toronto ON M5G 1X5; w.mcisaac@utoronto.ca*