Antibiotic prescribing for tonsillopharyngitis in a general practice setting

Can the use of Modified Centor Criteria reduce antibiotic prescribing?

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Background and objectives
Empirical treatment of sore throat with antibiotics has historically been aimed at preventing complications of group A β-haemolytic streptococcus infection. Threats posed by multi-resistant organisms mean that antimicrobial stewardship is important. The aim of this study was to investigate antibiotic prescribing for tonsillopharyngitis in relation to components of the Modified Centor Criteria (MCC) documented in consultation records.

Methods
Analysis of two rural Australian general practices was performed using clinic management software. A keyword search for 'tonsillopharyngitis/tonsillitis/pharyngitis' identified consultations.

Results
Antibiotic prescribing was frequent and congruent with existing studies; however, documented evidence of history and examination covering MCC components was associated with lower antibiotic prescribing (77.7% versus 85.5%, *P* <0.001; odds ratio: 2.4; 95% confidence interval: 1.8, 3.3, *P* <0.0001).

Discussion
We believe this is the first study that assesses the correlation between documentation and prescribing. Adopting and documenting MCC may improve appropriate prescription and patient safety and significantly reduce antibiotic prescription rates.

ACUTE TONSILLOPHARYNGITIS is a common cause of sore throat that is most often caused by a viral infection. Group A β-haemolytic streptococcus (GABHS) is a common cause of bacterial tonsillopharyngitis.[1] Studies have reported that approximately 5–17% of tonsillopharyngitis in adults is caused by bacteria, most often GABHS.[2,3] In children, the incidence is between 15% and 30%.[3–5] Studies have shown that the rate of prescribing for GABHS is unnecessarily high.[6]

Clinical assessment and treatment for streptococcal tonsillopharyngitis

Differentiating between viral and bacterial aetiologies of tonsillopharyngitis can be difficult.[7,8] Taking an appropriate history and using physical findings are suitable but these methods are not sufficiently specific or sensitive.[4]

Evidence of infection is supported by relevant history, including sore throat, fever, malaise, myalgia and headache. In addition, viral causes are strongly associated with the presence of a cough and/or rhinorrhoea.

A thorough assessment should include a physical examination of temperature and pulse; inspection of the oropharynx for erythema, exudate and palatal petechiae; and palpation for cervical lymphadenopathy.[9]

Contemporary axioms of GABHS tonsillopharyngitis management are symptomatic treatment through analgesia and hydration.[10–12] Evidence shows that treatment with antibiotics results in symptom resolution 16 hours earlier than for patients not given antibiotics.[13] In the paediatric population, it is thought that antibiotic treatment reduces severity of symptoms and their duration by one day.[14] Although antibiotics reduce the risk of complications (eg peritonsillar abscess), duration of symptoms and spread of the disease,[15] the numbers needed to treat are substantially high.[12,13,16,17] In high-risk populations, the benefits of antibiotics may be greater. This includes people aged 2–25 years in communities with a high incidence of acute rheumatic fever (eg Aboriginal and Torres Strait Islander communities in central and northern Australia, Maori and Pacific Islander people) and patients with existing rheumatic heart disease; chronic conditions such as diabetes, significant heart, lung and renal problems; and scarlet fever.[11,18] Therefore, it is important that prescribing in low-risk settings is appropriate and safe.

Case note documentation and prescribing habits

Over-prescribing of antibiotics for tonsillopharyngitis is a well-known phenomenon attributed to numerous factors.[19–22] Researchers have endeavoured to find reasons for over-prescribing, especially in general practice.[23,24] This is important for cost reduction and to prevent unnecessary exposure to side effects. On reviewing the literature, there

does not appear to be sufficient evidence that adequate documentation of clinical encounters reduces antibiotic prescribing. Linder et al prospectively showed that there was no significant difference in antibiotic prescribing between clinicians in two different arms (using a clinical decision tool and 'usual care'). However, the clinical decision tools were not as widely used as expected by participating clinicians.[25] Studies do show that good documentation is important for adequate assessment.[26,27] A study by Razai et al showed that antibiotic prescribing is reduced following educational intervention when Centor scores are used, but it is unclear whether there is a direct association.[28] Another study examined diagnostic coding and prescribing but was unable to assess for documentation of severity markers to aid prescribing.[29]

The primary aim of this study was to ask the question: does evidence of full documentation of the clinical signs and symptoms of tonsillopharyngitis in the notes reduce the prescribing of antibiotics?

Centor and McIsaac (Modified Centor score) criteria

Combinations of symptomatic and epidemiologic features have been used to develop clinical scores predicting the likelihood of tonsillopharyngitis being caused by GABHS.[30,31] Shaikh et al argued that none is sufficiently sensitive and specific to eliminate the need for microbiologic testing in children and adolescents given that even subjects with all clinical features in a particular scoring system can be confirmed to have streptococcal pharyngitis only approximately 35–50% of the time.[3,32] On the contrary, other guidelines argue there is no need for testing, except in specific circumstances.[11,12,18,33]

The McIsaac Score[6] or the Modified Centor Criteria (MCC), derived from 521 patients from a family practice in Toronto, Canada, and validated on 621 patients from 49 Ontario communities,[34] adjusts the Centor score on the basis of the patient's age. It is a clinical scoring tool to aid clinicians in prescribing antibiotics for acute tonsillopharyngitis in low-risk situations. Its use has been shown to reduce antibiotic prescribing by 88%.[35] Box 1 provides the diagnostic criteria and pre-test probability of streptococcal infection in relation to this score.[36] The diagnostic criteria have been available for many years and form part of guidelines in the UK, USA and Australia. However, the score is not specifically mentioned in the Australian guidelines.[18]

Recently, the Infectious Disease Society of America (IDSA) and American College of Physicians (ACP) revised the interpretation of the Centor score by suggesting that a rapid antigen detection test (RADT) ± culture be performed for every patient with a score of two or more (except in cases where obvious viral clinical and epidemiological features are present).[3,11,12,18] Studies have shown that this reduces antibiotic prescribing.[37,38] The National Institute of Clinical Excellence (NICE) and the Scottish Intercollegiate Guidelines Network suggest considering antibiotics for patients with scores of three or more.

GABHS is generally more common in children than infants and adults,[5] with overprescribing an issue for all groups. This study involved paediatric and adult populations, making the MCC an appropriate clinical tool to use.[6,7,9]

Methods

An exhaustive search for case-note entries for patients aged between 3 and 69 years diagnosed with pharyngitis, tonsillitis and tonsillopharyngitis between January and December 2015 was performed by using a filter and extraction method on Best Practice[39] and ZedMed.[40] Exclusion criteria were: those under three years of age and over 69 years of age, and those with high-risk comorbidities as identified by NICE.[11,18] This allowed for analysis of low-risk patient characteristics that are commonly seen in Australian general practice.[41]

On the basis of the Australian Standard Geographical Classification – Remoteness Areas systems, the rural clinics involved in this study were classified as RA2 (Large Inner Regional Centre – South Australia) and RA3 (Small Outer Regional Centre – South Australia) general practices. Ethical approval was sought from The Royal Australian College of General Practitioners (RACGP) National Research & Evaluation Ethics Committee (Approval number: NREEC 17-001) before data collection began. Patients were de-identified and therefore no identifiable data were included in the Excel spreadsheet.

The data were collected by the lead author (CP). A total of 21 clinicians were involved (13 fellowed general practitioners [GPs] and eight registrars) from the two clinics. There was no way of knowing whether these clinicians had knowledge of MCC. The lead author was not working at the practices in the period during which the data were obtained. Subordinate authors reviewed, critiqued and cleaned the data set before it was presented to additional authors who assisted with statistical analysis.

Patients included in the study were those who had presented for the first time for a new illness and had a recent onset of symptoms (three days or less). Patients who presented more than once were analysed further to assess from their

Box 1. Pre-test probability and diagnostic criteria of the Modified Centor Criteria score for streptococcal tonsillopharyngitis

Modified Centor Criteria score	Probability of streptococcal tonsillitis
–1 or 0	1–2%
1	5–10%
2	11–17%
3	28–35%
4	51–53%
5	51–53%

Age range (group A β-haemolytic streptococcus rare in patients aged <3 years): 3–14 years = +1; 15–44 years = 0; ≥45 years = –1
Exudate or swelling on tonsils: Yes = 1; No = 0
Tender/swollen anterior cervical lymph nodes: Yes = 1; No = 0
Fever (temperature ≥38˚C): Yes = 1; No = 0
Cough: Absence = 1; Presence = 0

medical notes whether this was a new illness or a continuation of the original one. Only the former were included in the analysis. If it was not clear from the notes whether this was a first presentation, then the patient was not included in the data.

Study data are summarised as means ± standard deviations (SD), medians and interquartile ranges (IQR), or frequencies and percentages as appropriate. Analyses were performed using STATA version 14.0 (Stata Corp, Texas, USA).[42] MCC yes and no demographics were compared using chi-squared tests. The odds ratios (OR) and *P* values were calculated using multivariable, adjusted mixed effects logistic regression, allowing for potential confounders, with clinicians as random effects (ie random intercepts). Statistical significance was set at $P < 0.01$ to allow for multiple tests.

Results

A total of 1761 patient consultations were screened. After exclusion criteria were applied, 1554 patients were analysed. None of these consultation notes had the term 'Centor' documented. In 733 consultations, the practitioner's documentation did not account for one or more of the MCC criteria required to calculate a score. The total number of patients who were prescribed antibiotics was 1265 (81.4%). Disregarding the MCC score, 77.7% (n = 638) of patients were prescribed antibiotics by clinicians who accounted for all the criteria for MCC in their assessment of the patient. Only 36 patients (2.3%) had a swab for culture sent for analysis. Of those, 23 cases were negative but had antibiotics prescribed.

When taking into consideration all clinicians, documented evidence of history and examination covering MCC components was associated with a statistically significantly lower rate of antibiotic prescribing (Table 1, 77.7% versus 85.5%, $P < 0.001$). Within the MCC groups, 17 (16.5%) patients with a score of 0 were prescribed antibiotics; 80 (58.8%) with a score of 1; 109 (86.5%) with a score of 2; 167 (87.4%) with a score of 3 and 100% with a score of 4 or more (Table 2).

Statistically significant associations were found for age group and MCC documentation after adjusting for other

Table 1. Demographics of the patients, clinicians and clinics involved as well as antibiotic prescribing with respect to Modified Centor Criteria documentation (n = 1554), chi-squared *P* values shown

Factor	Level	MCC – No	MCC – Yes	Total	*P* value
Participants (n)		733	821	1,554	
Antibiotics given	No	106 (14.5%)	183 (22.3%)	289 (18.6%)	<0.001
	Yes	627 (85.5%)	638 (77.7%)	1,265 (81.4%)	
Sex	Male	281 (38.3%)	320 (39.0%)	601 (38.7%)	0.80
	Female	452 (61.7%)	501 (61.0%)	953 (61.3%)	
Age, median (IQR)		21.0 (10.0, 33.0)	13.0 (9.0, 27.0)	16.0 (9.0, 30.0)	<0.001
Clinician	Fellow	369 (50.3%)	382 (46.5%)	751 (48.3%)	0.13
	Registrar	364 (49.7%)	439 (53.5%)	803 (51.7%)	
MCC score	0	0 (0.0%)	103 (12.5%)	103 (6.7%)	<0.001
	1	0 (0.0%)	136 (16.6%)	136 (8.9%)	
	2	0 (0.0%)	126 (15.3%)	126 (8.1%)	
	3	0 (0.0%)	191 (23.3%)	191 (12.3%)	
	4	0 (0.0%)	160 (19.5%)	160 (10.3%)	
	5	0 (0.0%)	105 (12.8%)	105 (6.8%)	
	No	733 (100.0%)	0 (0.0%)	733 (100%)	
Age group (years)	3–14	226 (30.8%)	510 (62.1%)	736 (47.4%)	<0.001
	15–44	446 (60.8%)	240 (29.2%)	686 (44.1%)	
	45–69	61 (8.3%)	71 (8.6%)	132 (8.5%)	
Clinic	1	451 (61.5%)	455 (55.4%)	906 (58.3%)	0.01
	2	282 (38.5%)	366 (44.6%)	648 (41.7%)	

IQR; interquartile range; MCC, Modified Centor Criteria

variables in the multivariable model and the random effects (Table 3). The odds of being prescribed antibiotics when there was no MCC documentation were 2.4 times that of patients for which full documentation was recorded after adjusting for sex, age, clinic and clinician (OR: 2.445; 95% confidence interval: 1.80, 3.32; P <0.001). Antibiotic prescription rates were lower for the two older age groups when compared with patients aged 3–14 years (P <0.001).

Given these findings, a suggested approach to the management of GABHS tonsillopharyngitis was devised, as shown in Figure 1.

Discussion

The demographic characteristics of the population were comparable to the Australian population in terms of sex and age.[41] This study showed that adequate documentation was lacking in almost half of the consultations. It also showed that antibiotic prescribing for tonsillopharyngitis is a common practice irrespective of MCC score. This is in contrast with guidelines in Australia, UK and USA.[3,11,12,18] Overall, antibiotic prescribing rates were higher than those reported in a recent Australian study.[43]

Antibiotics were prescribed significantly less often for patients who had all MCC criteria documented in their medical records. A compelling finding shown here is that when a clinician accounts for all the data points in their assessment that are required to calculate a validated score such as the MCC, prescribing of antibiotics approaches empirically validated practice. Therefore, inclusion of consultations with evidence of missing data of MCC criteria is important. However, room for improvement was evident, given that patients scoring 0, 1 and 2 still received antibiotics unnecessarily.

There was a similarity in prescribing for patients with a score of 2 and 3 in comparison to those cases where there was inadequate documentation. This may create an unexplained paradigm of reduced prescribing in the cases where full documentation was provided, given that all those with scores of 4–5 were prescribed antibiotics. It may be that prescribing rates for those who scored 1 (ie those who do not have tonsillitis) could account for the lower prescribing rates overall. Irrespective of this, this study will hopefully educate clinicians two-fold, in that:

- documentation is important to formulate an appropriate evidence-based management plan
- patients with scores of ≤2 (possibly even ≤3) do not need antibiotics.

Antibiotics were prescribed for 100% of patients who scored 4 and 5, which may have been necessary on the basis of the clinician's assessment. However, there is an argument that low-risk patients who have these scores do not always need antibiotics, given the low risk of complications and the fact that these presentations may be viral in origin.[16,44,45]

The results of this study show that antibiotic prescribing in the younger age groups is high irrespective of whether the MCC criteria are addressed or not. This may be because a younger population has a higher incidence of GABHS and therefore correlates to higher prescribing.[3–5] However, it is also important to note that prescribing was high when the MCC was 1 or 2 in this age group. Again, this deviates from the guidelines.[3,11,12,18] The older age groups did have reduced prescribing rates, which is reassuring given that these age groups historically tended to have over-prescribing for respiratory-type infections.[21]

While other studies have analysed many parameters of patient, clinician and consultation factors in relation to antibiotic prescribing in sore throat, we believe this is the first study of this phenomenon to consider specific signs and symptoms in individual patients in relation to prescribing decisions. Therefore, the divergence in our results from existing research may be explained by the factor of 'signs and symptoms gathered' and considered by the clinician in their decision making, as opposed to focusing on clinician experience and demographics more globally.

Table 2. Comparison of antibiotic prescribing across the Modified Centor Criteria scores and those not documented

Modified Centor Criteria score	Antibiotics given (%)		
	No	Yes	Total
0	86 (83.5)	17 (16.5)	103 (100.0)
1	56 (41.2)	80 (58.8)	136 (100.0)
2	17 (13.5)	109 (86.5)	126 (100.0)
3	24 (12.6)	167 (87.4)	191 (100.0)
4	0 (0.0)	160 (100.0)	160 (100.0)
5	0 (0.0)	105 (100.0)	105 (100.0)
No	106 (14.5)	627 (85.5)	733 (100.0)
Total	289 (18.6)	1,265 (81.4)	1,554 (100.0)

Guidelines from NICE recommend considering three-day delayed prescription or immediate antibiotics for those with an MCC of >3.[11,12] This was based on a Cochrane review showing that delayed prescribing reduced antibiotic use (from 93% to 32%) when compared with immediate antibiotic prescribing for respiratory infections.[24,46,47] The delayed antibiotic strategy may be an option for patients with scores of 3–5 who may not need antibiotics; it may also improve cost-effectiveness, given that evidence shows antibiotic compliance is poor.[48]

RADT is controversial but is supported by the IDSA and ACP. Our study showed that swabbing is not common practice. The role of swabs in investigating GABHS may be most advantageous in treatment of high-risk patients, delayed antibiotics and failed treatment. Shulman et al reported that using RADT may indeed reduce antibiotic prescribing.[3] It raises the question of whether laboratory testing would have reduced the antibiotic prescribing in this sample of patients and by how much.

Limitations

The major limitation of this study is that it relies on retrospective analysis of medical records and assumes that data recorded is an accurate reflection of information gathered during clinical encounters. All medical practitioners are compelled to document every critical aspect of every assessment they make throughout their career for both medicolegal and clinical purposes. Therefore, it is reasonable to assume that the record reflects the reality of the assessment made in each encounter. Consequently, it is justified to include encounters in our dataset for which insufficient data were recorded by the clinician, as perhaps the most inappropriate of prescribing habits within the spectrum are those where antibiotics are prescribed in the absence of even a complete assessment of the patient being documented. Another limitation is the inability to know for certain whether any of the clinicians were aware of the MCC, which could bias the results.

Conclusion

This study showed that prescribing of antibiotics in tonsillopharyngitis within low-risk populations was high. The importance of adequate documentation to facilitate treatment is important. Clinicians in Australia may choose not to use diagnostic testing, but there is a place for this in certain situations. Patient satisfaction can be maintained irrespective of whether antibiotics are given, and using the MCC as a rationale for decisions could be the starting point. To date, there is an absence of management guidelines specifically for this group of infections in the RACGP's current portfolio of guidance for GPs.

Future studies that investigate the characteristics of clinicians who routinely prescribe antibiotics for these infections may identify those who could benefit from education programs. Another potential course of investigation would be to look at whether laboratory testing reduces antibiotic prescribing in the general population in general practice.

Table 3. Multi-level logistic regression analysis showing association between antibiotics given status and variables. Clinician was included as random effects.

Antibiotics given (Yes/No)	Odds ratio (95% confidence interval)	*P* value
Sex		
Male	1 (Reference)	
Female	0.980 (0.745, 1.289)	0.885
Age group (years)		
3–14	1 (Reference)	
15–44	0.398 (0.289, 0.535)	<0.0001
45–69	0.271 (0.181, 0.406)	<0.0001
Modified Centor Criteria documented		
Yes	1 (Reference)	
No	2.445 (1.801, 3.320)	<0.0001
Clinic		
1	1 (Reference)	
2	0.917 (0.628, 1.339)	0.653

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References

1. Carapetis JR, Steer AC, Mulholland EK, Weber M. The global burden of group A streptococcal diseases. Lancet Infect Dis 2005;5(11):685–94. doi: 10.1016/S1473-3099(05)70267-X.
2. Linder JA, Stafford RS. Antibiotic treatment of adults with sore throat by community primary care physicians: A national survey, 1989–1999. J Am Med Assoc 2001;286(10):1181–86. doi: 10.1001/jama.286.10.1181.
3. Shulman ST, Bisno AL, Clegg HW, et al. Clinical practice guideline for the diagnosis and management of group A streptococcal pharyngitis: 2012 update by the Infectious Diseases Society of America. Clin Infect Dis 2012;55(10):1279–82. doi: 10.1093/cid/cis847.
4. Pichichero ME. Group A streptococcal tonsillopharyngitis: Cost-effective diagnosis and treatment. Ann Emerg Med 1995;25(3):390–403. doi: 10.1016/S0196-0644(95)70300-4.
5. Tsevat J, Kotagal UR. Management of sore throats in children: A cost-effectiveness analysis. Arch Pediatr Adolesc Med 1999;153(7):681–88.

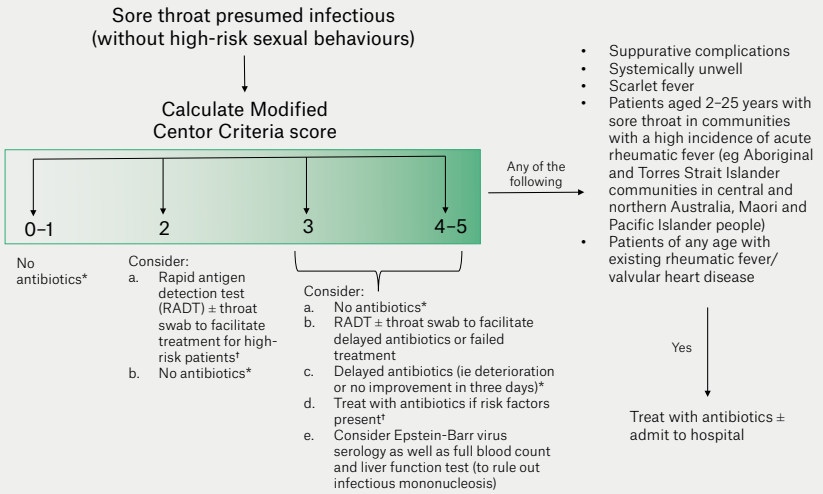

Figure 1. Suggested approach for the management of presumed group A β-haemolytic streptococcus tonsillopharyngitis using the Modified Centor Criteria

**Adequate and clear instructions to patients/parents should be given regarding the treatment option chosen.*

†Risk factors include:

- *increased risk of severe infection or complications (diabetes, immunosuppressed)*
- *significant heart, lung, renal, liver or neuromuscular disease; cystic fibrosis; young children born prematurely.*

6. McIsaac WJ, White D, Tannenbaum D, Low DE. A clinical score to reduce unnecessary antibiotic use in patients with sore throat. Can Med Assoc J 1998;158(1):75–83.
7. Lieberman D, Shvartzman P, Korsonsky I, Lieberman D. Aetiology of respiratory tract infections: Clinical assessment versus serological tests. Br J Gen 2001;51(473):998–1000.
8. Wannamaker LW. Perplexity and precision in the diagnosis of streptococcal pharyngitis. Am J Dis Child 1972;124(3):352–58.
9. Ebell MH, Smith MA, Barry HC, Ives K, Carey M. The rational clinical examination. Does this patient have strep throat? Jama 2000;284(22):2912–18.
10. ENT UK. Indications for Tonsillectomy: Position Paper, ENT UK 2009. London: ENT UK, 2009.
11. National Institute for Health and Care Excellence. Sore throat (acute): Antimicrobial prescribing. London: NICE, 2017. Available at www.nice.org.uk/guidance/ng84/chapter/Summary-of-the-evidence [Accessed 29 April 2019].
12. SIGN. Management of sore throat and indications for tonsillectomy. Scotland: Healthcare Improvement Scotland, 2019. Available at www.sign.ac.uk/sign-117-management-of-sore-throat-and-indications-for-tonsillectomy.html [Accessed 17 April 2019].
13. Spinks A, Glasziou PP, Del Mar CB. Antibiotics for sore throat. Cochrane Database Syst Rev 2013(11):Cd000023. doi: 10.1002/14651858.CD000023.pub4.
14. Denny FW. Effect of treatment on streptococcal pharyngitis: Is the issue really settled? Pediatr Infect Dis 1985;4(4):352–54.
15. Aalbers J, O'Brien KK, Chan WS, et al. Predicting streptococcal pharyngitis in adults in primary care: A systematic review of the diagnostic accuracy of symptoms and signs and validation of the Centor score. BMC Med 2011;9:67. doi: 10.1186/1741-7015-9-67.
16. Little P, Stuart B, Hobbs FDR, et al. Predictors of suppurative complications for acute sore throat in primary care: prospective clinical cohort study. BMJ 2013;347:f6867. doi: 10.1136/bmj.f6867.
17. Petersen I, Johnson AM, Islam A, Duckworth G, Livermore DM, Hayward AC. Protective effect of antibiotics against serious complications of common respiratory tract infections: Retrospective cohort study with the UK General Practice Research Database. BMJ 2007;335(7627):982. doi: 10.1136/bmj.39345.405243.BE.
18. Expert Group for Antibiotic. Acute pharyngitis and/or tonsillitis. In: eTG complete [Internet]. Melbourne: Therapeutic Guidelines Limited, 2014.
19. Fischer T, Fischer S, Kochen MM, Hummers-Pradier E. Influence of patient symptoms and physical findings on general practitioners' treatment of respiratory tract infections: A direct observation study. BMC Fam Pract 2005;6:6. doi: 10.1186/1471-2296-6-6.
20. Akkerman AE, Kuyvenhoven MM, van der Wouden JC, Verheij TJM. Determinants of antibiotic overprescribing in respiratory tract infections in general practice. J Antimicrob Chemother 2005;56(5):930–36. doi: 10.1093/jac/dki283.
21. Akkerman AE, van der Wouden JC, Kuyvenhoven MM, Dieleman JP, Verheij TJM. Antibiotic prescribing for respiratory tract infections in Dutch primary care in relation to patient age and clinical entities. J Antimicrob Chemother 2004;54(6):1116–21. doi: 10.1093/jac/dkh480.
22. Pouwels KB, Dolk FCK, Smith DRM, Robotham JV, Smieszek T. Actual versus 'ideal' antibiotic prescribing for common conditions in English primary care. J Antimicrob Chemother 2018;73 Suppl 2:19–26. doi: 10.1093/jac/dkx502.
23. Harris AM, Hicks LA, Qaseem A. Appropriate antibiotic use for acute respiratory tract infection in adults: Advice for high-value care from the American college of physicians and the centers for disease control and prevention. Ann Intern Med 2016;164(6):425–34. doi: 10.7326/M15-1840.
24. Del Mar CB, Scott AM, Glasziou PP, et al. Reducing antibiotic prescribing in Australian general practice: Time for a national strategy. Med J Aust 2017;207(9):401–6. doi: 10.5694/mja17.00574.
25. Linder JA, Schnipper JL, Tsurikova R, et al. Documentation-based clinical decision support to improve antibiotic prescribing for acute respiratory infections in primary care: A cluster randomised controlled trial. Inform Prim Care 2009;17(4):231–40.
26. Kuhn T, Basch P, Barr M, Yackel T. Clinical documentation in the 21st century: Executive summary of a policy position paper from the American College of Physicians. Ann Intern Med 2015;162(4):301–3. doi: 10.7326/M14-2128.
27. Abernethy AP, Herndon JE, Wheeler JL, Rowe K, Marcello J, Patwardhan M. Poor documentation prevents adequate assessment of quality metrics in colorectal cancer. J Oncol Pract 2009;5(4):167–74. doi: 10.1200/JOP.0942003.
28. Razai M, Hussain K. Improving antimicrobial prescribing practice for sore throat symptoms in a general practice setting. BMJ 2017;6:u211706.w4738. doi: 10.1136/bmjquality.u211706.w4738.
29. Smieszek T, Pouwels KB, Dolk FCK, Smith DRM, Hopkins S, Sharland M, et al. Potential for reducing inappropriate antibiotic prescribing in English primary care. J Antimicrob Chemother 2018;73 Suppl 2:ii36–ii43. doi: 10.1093/jac/dkx500.
30. 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(3):239–46. doi: 10.1177/0272989X8100100304.
31. Breese BB. A simple scorecard for the tentative diagnosis of streptococcal pharyngitis. Am J Dis Child 1977;131(5):514–17. doi: 10.1001/archpedi.1977.02120180028003.
32. Shaikh N, Swaminathan N, Hooper EG. Accuracy and precision of the signs and symptoms of streptococcal pharyngitis in children: A systematic review. J Pediatr 2012;160(3):487–93.e3. doi: 10.1016/j.jpeds.2011.09.011.
33. The Royal Children's Hospital Melbourne. Clinical Practice Guidelines: Sore Throat. Parkville, Vic: The Royal Children's Hospital Melbourne, 2019. Available at www.rch.org.au/clinicalguide/guideline_index/Sore_throat [Accessed 19 April 2019].
34. Fine AM, Nizet V, Mandl KD. Large-scale validation of the Centor and McIsaac scores to predict group A streptococcal pharyngitis. Arch Intern Med 2012;172(11):847–52. doi: 10.1001/archinternmed.2012.950.
35. McIsaac WJ, Goel V, To T, Low DE. The validity of a sore throat score in family practice. CMAJ 2000;163(7):811–15.
36. MDCalc. Centor score (modified/McIsaac) for strep pharyngitis. New York: MD Aware, 2018. Available at www.mdcalc.com/centor-score-modified-mcisaac-strep-pharyngitis/#how-to-use [Accessed 19 April 2019].

37. Kose E, Kose SS, Akca D, et al. The effect of rapid antigen detection test on antibiotic prescription decision of clinicians and reducing antibiotic costs in children with acute pharyngitis. J Trop Pediatr 2016;62(4):308–15. doi: 10.1093/tropej/fmw014.
38. Llor C, Madurell J, Balague-Corbella M, Gomez M, Cots JM. Impact on antibiotic prescription of rapid antigen detection testing in acute pharyngitis in adults: A randomised clinical trial. Br J Pract 2011;61(586):e244–51. doi: 10.3399/bjgp11X572436.
39. Best Practice [Software]. Bundaberg, Qld: Best Practice, 2016.
40. Zedmed [Software]. Melbourne: Zedmed, 2017.
41. Australian Bureau of Statistics. National Health Survey: Asthma and other respiratory conditions, 1995. Canberra: ABS, 1998.
42. StataCorp. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP, 2015.
43. Dallas A, van Driel M, Morgan S, et al. Antibiotic prescribing for sore throat: A cross-sectional analysis of the ReCEnT study exploring the habits of early-career doctors in family practice. Family practice. 2016;33(3):302–8. doi: 10.1093/fampra/cmw014.
44. Mistik S, Gokahmetoglu S, Balci E, Onuk FA. Sore throat in primary care project: A clinical score to diagnose viral sore throat. Fam Pract 2015;32(3):263–68. doi: 10.1093/fampra/cmv015.
45. Little P, Williamson I. Sore throat management in general practice. Fam Pract 1996;13(3):317–21. doi: 10.1093/fampra/13.3.317.
46. Spurling G. Review: Delayed or immediate prescriptions of antibiotics have similar clinical outcomes in respiratory infections. BMJ 2008;13(2):42. doi: 10.1136/ebn.11.2.46.
47. Spurling GKP, Del Mar CB, Dooley L, Foxlee R, Farley R. Delayed antibiotic prescriptions for respiratory infections. Cochrane Database Syst Rev 2017;9(4):CD004417. doi: 10.1002/14651858.CD004417.pub5.
48. Kardas P. Patient compliance with antibiotic treatment for respiratory tract infections. J Antimicrob Chemother 2002;49(6):897–903. doi: 10.1093/jac/dkf046.

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