Centor criteria in children in a pediatric emergency department: A retrospective cohort study

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Title

Centor criteria in children in a pediatric emergency department: A retrospective cohort study

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Centor criteria in children.

Keywords

Sore throat, Centor criteria, Group A β Hemolytic Streptococcus, antibiotics policy

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Data Sharing

Extra data is available by emailing Inge Roggen at inge.roggen@uzbrussel.be

Contributor's Statement Page

Inge Roggen, Gerlant van Berlaer, Frans Gordts, Denis Pierard, Ives Hubloue fulfil all three of the ICMJE guidelines for authorship.

Article summary

Article focus

- To evaluate the correlation between Centor criteria and presence of GABHS in children with sore throat admitted to our emergency department, in order to evaluate the value of this prediction rule.

Key messages

- Results confirm the ineffectiveness of Centor criteria as a predicting factor for finding GABHS in a throat swab culture in children.

Strengths and limitations

- The strength of this study is the large number of children included. The major limitation is the fact that not all children received a throat swab, thus introducing a selection bias.

Abstract

Background

Centor criteria (fever > 38.5°C, swollen tender anterior cervical lymph nodes, tonsillar exudate and absence of cough) are an algorithm to assess the probability of Group A β Hemolytic Streptococcus (GABHS) as the origin of sore throat, developed for adults.

Objective

To evaluate the correlation between Centor criteria and presence of GABHS in children with sore throat admitted to our Pediatric Emergency Department.

Methods

Using a retrospective cohort study design, we analyzed all medical records (from 2008 to 2010) of children between the age of 2 and 16 years old, who were diagnosed with pharyngitis, tonsillitis or sore throat; had a throat swab culture for GABHS and had all four Centor criteria scored. Out of a total 2118 visits for sore throat, 441 met our criteria. The children were divided into two groups: 2-5 and 5-16 years old.

Results

The prevalence of GABHS was higher in the older children compared to the preschoolers (38.7 vs. 27.6; p=0.01), overall prevalence was 32%. There was no significant difference in prevalence of GABHS for all different Centor scores within an age group.

Likelihood ratio's (LR) demonstrate that none of the individual symptoms, nor a Centor score of ≥3 seems to be effective in ruling in or ruling out GABHS. Pooled LR (CI) for Centor ≥ 3 was 0.67 (0.50-0.90) for the preschoolers and 1.37 (1.04-1.79) for the older children.

Conclusion

Our results confirm the ineffectiveness of Centor criteria as a predicting factor for finding GABHS in a throat swab culture in children.

Introduction

In 1981 Centor et al. developed four criteria to predict the probability of the presence of Streptococcus pyogenes or Group A β Hemolytic Streptococcus (GABHS) in a throat swab culture [1]. When all four criteria (fever > 38.5°C, swollen tender anterior cervical lymph nodes, tonsillar exudate and absence of cough) are present, the probability of GABHS is just above 50%. When 2 or less criteria are present, the probability is below 15%. Hence, Centor criteria are often used as a tool to assess the absence of GABHS, rather than the presence [2, 3, 4]. It should also be noted that these criteria were specifically developed for adults [1]. More recently (2000) McIsaac et al. developed modified criteria, which add the age of the patient [5, 6] (+1 if age 3-14, 0 if age 15-44 and -1 if age ≥ 45), taking into account the fact that GABHS is more prevalent in the age group of 5 to 15 years [2, 7, 8, 9, 10]. Still several studies have shown that nor signs and symptoms, nor signs and symptoms combined as prediction rules, were reliable to distinguish between GABHS and non-GABHS pharyngitis [11, 12, 13, 14, 15, 16].

The administration of antibiotics used to be indicated, based on the incidence of non-suppurative complications (post-streptococcal glomerulonephritis and reactive arthritis) after streptococcal pharyngitis, but a large Cochrane review by Del Mar et al. [17] state that the use of antibiotics (AB), in otherwise healthy individuals, is no longer indicated, as not only the incidence of non-suppurative complications has disappeared in the developed world since the late 1960's but also because antibiotics will not shorten disease duration or symptoms [17, 18]. With the possibility of adverse effects of AB, the benefit to risk ratio is no longer in favor administering AB to otherwise healthy individuals with a streptococcal pharyngitis.

In our pediatric emergency department (PED), physicians are thought to follow the guidelines of the Belgian Antibiotic Policy Coordination Committee (BAPCOC). BAPCOC guidelines are based on the review by Del Mar et al [17]. And yet we found that in our PED, in 2009 and 2010, out of 1345 otherwise healthy children, 35% was prescribed AB (unpublished data). For general practitioners in Flanders, the prescription rate is as high as 50%, even without knowing whether or not the pharyngitis was caused by GABHS [2]. As many clinicians tend to rely on signs and symptoms, rather than on a strep test or throat swab culture, we wanted to evaluate the correlation between Centor criteria and presence of GABHS in children with sore throat admitted to our PED, in order to evaluate the value of this prediction rule.

Patients and methods

Using a retrospective cohort study design, we analyzed all medical records of children between the age 2 and 16 who were admitted to our PED between 1/1/2008 and 31/12/2010. The study was approved by the local ethical committee of the UZ Brussel University hospital.

All our records are digitalized and all diagnoses in our records are registered according to the International Statistical Classification of Diseases and Related Health Problems (ICD-9) codes. All files of children who received a throat swab for GABHS culture with the following ICD-9 codes infectious mononucleosis (075), nasopharyngitis (460), pharyngitis (462), tonsillitis (463) and sore throat (784.1) were included for analysis. Children with underlying chronic respiratory, cardiac, hematological or immunological diseases and children who already received antibiotics (AB) prior to the PED consult were excluded. Only records with full disease history were selected (figure 1).

We divided the patients into 2 groups: preschoolers (≥ 2 and < 5 years old) and kids (≥ 5 and < 16 years old), as the prevalence of GABHS is different in both groups.

Statistical analysis was performed using MedCalc® version 12.3.0 (MedCalc Software bvba, Mariakerke, Belgium). All data are presented as mean ± standard deviation (SD) or as median (range), when not normally distributed. D'Agostino-Pearson K-squared test was used for assessing normality of data. Spearman's rho test was used to calculate rank correlation coefficients.

Results

Out of all 2,118 PED visits for sore throat, 441 (230 boys - 211 girls) met our criteria (graph 1). Median age (range) was 5.0 years old (2.0 - 15.9). Median age (range) was respectively 3.3 years old (2.0 - 4.9) in the preschoolers (n=286) and 7.6 (5.0 - 15.9) in the kids (n=155). Throat swab culture for GABHS was positive for 32% of the patients. In kids, the prevalence of GABHS was higher compared to the preschoolers (38.7 vs. 27.6; p=0.01).

The mean Centor score was similar between preschoolers and kids (2.6 ± 0.9 vs. 2.6 ± 0.9; p=0.8). The mean (95% confidence interval) presence of GABHS in our preschoolers was respectively: 45% (28-63%) with less than 2 Centor criteria present, 33% (24-43%) with 2, 23% (15-31%) with 3 and 13% (3-24%) with 4 criteria were present. In kids this was 35% (10-61%) when ≤ 1, 31% (17-44%) when 2, 43% (31-55%) when 3 and 45% (21-69%) when 4 criteria were present (table 1).

Preschoolers with a positive throat swab culture had significantly less often tonsillar exudate, compared to preschoolers (59 vs. 39%; p=0.003) or kids (55 vs. 39%; p=0.04) with a negative culture, but not compared to kids with a positive culture (50 vs. 39%; p=0.2). Kids with a positive throat swab culture did significantly more often present with an absence of cough, compared to all 3 other groups (p<0.05). The occurrence of all other symptoms did not differ significantly between all four groups (figure 2).

Likelihood ratio's (LR) for both age groups are shown in table 2a and 2b. Neither one of the individual symptoms, nor a Centor score of ≥ 3 seems to be effective in ruling in or ruling out GABHS.

Discussion

Our results confirm the higher prevalence of GABHS in children between the ages of 5 and 15. The prevalence of GABHS in both our age groups is slightly higher compared to results in literature [5, 19, 20]. This is probably due to selection bias: not all children with a sore throat had a throat swab culture for GABHS and our physicians seem to have several different reasons on which they base their decision of whether or not taking a throat swab culture.

We can also confirm that Centor criteria are unreliable to predict the presence of GABHS in a throat swab culture in otherwise healthy children, with no actual AB treatment. With a comparable prevalence of GABHS for all different categories, similar to the prevalence of the overall population prevalence [5, 21], it is clear that, at least in children, Centor criteria are not a good tool to assess the probability of GABHS. With a combined likelihood ratio (95% confidence interval) for Centor ≥ 3 of 0.67 (0.50 – 0.90) for the preschoolers and 1.37 (1.04 -1.79) for the kids, our results are in line with the results of the metaanalysis of Shaikh et al. earlier this year, who found a pooled LR (CI) for Centor ≥ 3 of 1.73 (1.28 – 2.35) [16].

When it comes to evaluating the absence of GABHS in our group, children with less than 3 Centor criteria have a 72% probability for a negative culture for GABHS. There were no differences between both age groups, which might be partly due to the observation that in the younger children there is a significantly higher reporting of fever (84.5 vs. 72.7%; p=0.004) and coughing is more often present (80.8 vs. 65.4%; p=0.004), resulting in a similar average Centor score for both age groups. Still, a 72% probability for a negative culture for GABHS is very close to the average GABHS prevalence in this population. Thus, letting us conclude that Centor criteria are not a valid tool for assessing the absence of GABHS either. Even though the use of AB in streptococcal pharyngitis is disputed, physicians tend to have a low threshold to prescribe AB, judging only on clinical features, without knowing whether or not GABHS is the culprit (Roggen et al. unpublished data) [2]. Our results confirm that, at least in children, Centor criteria are an unreliable tool to assess the probability of the presence of GABHS, thus it's use should be discouraged.

The strength of this study is the large number of children included. The major limitation is the fact that not all children received a throat swab, thus introducing a selection bias.

Conclusion

Our results confirm the ineffectiveness of Centor criteria as a predicting factor for the presence or absence of GABHS in a throat swab culture in children from 2 to 15 years old.

Acknowledgements

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Figures

Figure 1. Flow-chart showing the criteria for inclusion and exclusion.

Figure 2. Prevalence (%) of all 4 Centor criteria in children with respectively a GABHS positive and GABHS negative throat swab culture.

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Table 1. Centor criteria and presence of GABHS.

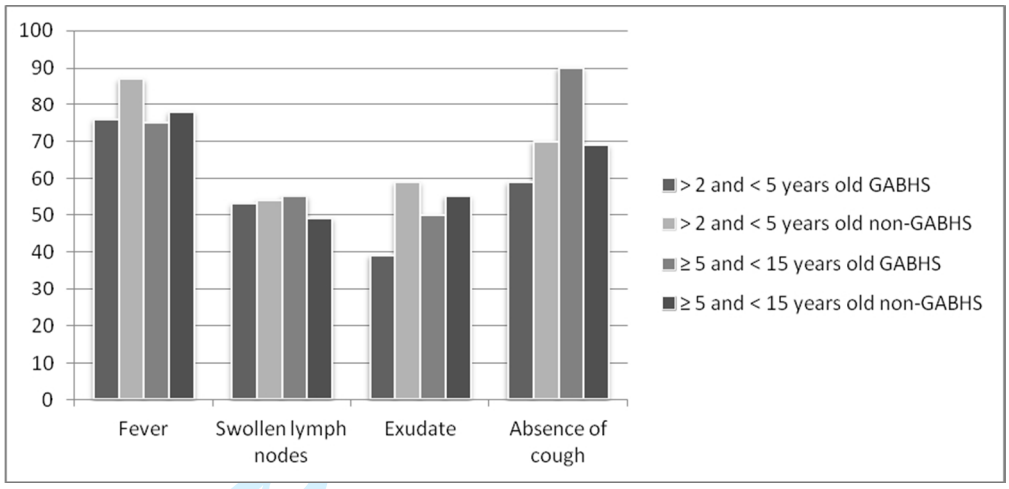
Number of criteria present	<2	2	3	4
Number of preschoolers (2-4 years)	33	96	113	44
GABHS prevalence (95% CI), %	45 (28-63)	33 (24-43)	23 (15-31)	13 (3-24)
Number of kids (5-15 years)	17	49	69	20
GABHS prevalence (95% CI), %	35 (10-61)	31 (17-44)	43 (31-55)	45 (21-69)

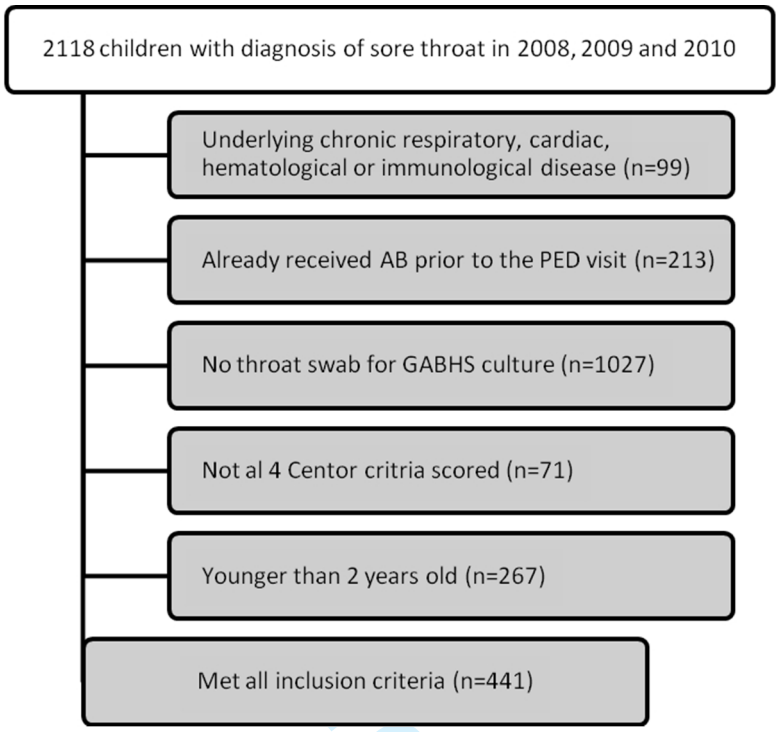
Table 2a. Correlation between clinical parameters and the presence of GABHS (2-4 years old).

Clinical parameter	Positive likelihood ratio (CI)	Negative likelihood ratio (CI)
Fever	0.87 (0.76 – 0.99)	1.91 (1.13 – 3.26)
Tonsillar exudate	0.67 (0.49 – 0.90)	1.48 (1.16 – 1.88)
Swollen lymph nodes	0.98 (0.77 – 1.25)	1.02 (0.77 – 1.35)
Absence of cough	0.85 (0.69 – 1.04)	1.35 (0.96 – 1.90)
Centor ≥ 3	0.67 (0.50 – 0.90)	1.50 (1.17 – 1.92)

Table 2b. Correlation between clinical parameters and the presence of GABHS (5-15 years).

Clinical parameter	Positive likelihood ratio (CI)	Negative likelihood ratio (CI)
Fever	0.96 (0.80 – 1.15)	1.13 (0.63 – 2.02)
Tonsillar exudate	0.91 (0.67 – 1.25)	1.10 (0.79 – 1.55)
Swollen lymph nodes	1.11 (0.82 – 1.51)	0.89 (0.63 – 1.26)
Absence of cough	1.30 (1.11 – 1.52)	0.33 (0.14 – 0.74)
Centor ≥ 3	1.37 (1.04 -1.79)	0.67 (0.45 – 0.99)





STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, explain how loss to follow-up was addressed
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Report numbers of outcome events or summary measures over time
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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In our pediatric emergency department (PED), physicians are thought to follow the guidelines of the Belgian Antibiotic Policy Coordination Committee (BAPCOC). BAPCOC guidelines are based on the review by Del Mar et al [17]. And yet we found that in our PED, in 2009 and 2010, out of 1345 otherwise healthy children, 35% was prescribed AB (unpublished data). For general practitioners in Flanders, the prescription rate is as high as 50%, even without knowing whether or not the pharyngitis was caused by GABHS [2]. As many clinicians tend to rely on signs and symptoms, rather than on a strep test or throat swab culture, we wanted to evaluate the correlation between Centor criteria and presence of GABHS in children with sore throat admitted to our PED, in order to evaluate the value of this prediction rule.

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Using a retrospective cohort study design, we analyzed all medical records of children between the age 2 and 16 who were admitted to our PED between 1/1/2008 and 31/12/2010. The study was approved by the local ethical committee of the UZ Brussel University hospital.

All our records are digitalized and all diagnoses in our records are registered according to the International Statistical Classification of Diseases and Related Health Problems (ICD-9) codes. All files of children who received a throat swab for GABHS culture with the following ICD-9 codes infectious mononucleosis (075), nasopharyngitis (460), pharyngitis (462), tonsillitis (463) and sore throat (784.1) were included for analysis. Children with underlying chronic respiratory, cardiac, hematological or immunological diseases and children who already received antibiotics (AB) prior to the PED consult were excluded. Only records with full disease history were selected (figure 1).

We divided the patients into 2 groups: preschoolers (≥ 2 and < 5 years old) and kids (≥ 5 and < 16 years old), as the prevalence of GABHS is different in both groups.

Statistical analysis was performed using MedCalc® version 12.3.0 (MedCalc Software bvba, Mariakerke, Belgium). All data are presented as mean ± standard deviation (SD) or as median (range), when not normally distributed. D'Agostino-Pearson K-squared test was used for assessing normality of data. Spearman's rho test was used to calculate rank correlation coefficients.

Results

Out of all 2,118 PED visits for sore throat, 441 (230 boys - 211 girls) met our criteria (graph 1). Median age (range) was 5.0 years old (2.0 - 15.9). Median age (range) was respectively 3.3 years old (2.0 - 4.9) in the preschoolers (n=286) and 7.6 (5.0 - 15.9) in the kids (n=155). Throat swab culture for GABHS was positive for 32% of the patients. In kids, the prevalence of GABHS was higher compared to the preschoolers (38.7 vs. 27.6; p=0.01). Median age and gender distribution was not statistically significant between the included and excluded children.

The mean Centor score was similar between preschoolers and kids (2.6 ± 0.9 vs. 2.6 ± 0.9; p=0.8). The mean (95% confidence interval) presence of GABHS in our preschoolers was respectively: 45% (28-63%) with less than 2 Centor criteria present, 33% (24-43%) with 2, 23% (15-31%) with 3 and 13% (3-24%) with 4 criteria were present. In kids this was 35% (10-61%) when ≤ 1, 31% (17-44%) when 2, 43% (31-55%) when 3 and 45% (21-69%) when 4 criteria were present (table 1).

Preschoolers with a positive throat swab culture had significantly less often tonsillar exudate, compared to preschoolers (59 vs. 39%; p=0.003) or kids (55 vs. 39%; p=0.04) with a negative culture, but not compared to kids with a positive culture (50 vs. 39%; p=0.2). Kids with a positive throat swab culture did significantly more often present with an absence of cough, compared to all 3 other groups (p<0.05). The occurrence of all other symptoms did not differ significantly between all four groups (figure 2).

Likelihood ratio's (LR) for both age groups are shown in table 2a and 2b. Neither one of the individual symptoms, nor a Centor score of ≥ 3 seems to be effective in ruling in or ruling out GABHS.

We note that children included in our results (compared to those excluded) had more often tonsillar exudate (53.3 vs. 32.7%; p<0.0001), fever (81.6 vs. 74.4%; p=0.002) and swollen cervical lymph nodes (53.1 vs. 43.4%; p<0.05); and thus a higher Centor score (2.2 vs. 2.6; p<0.0001).

Discussion

Our results confirm the higher prevalence of GABHS in children between the ages of 5 and 15. The prevalence of GABHS in both our age groups is slightly higher compared to results in literature [5, 19, 20]. This is probably due to selection bias: not all children with a sore throat had a throat swab culture for GABHS and our physicians seem to have several different reasons on which they base their decision of whether or not taking a throat swab culture.

In children between the age of 2 and 5 with a Centor score below 2, we found a rather high prevalence of GABHS, which might be due to asymptomatic carriership [20]. Also, in this group, a decrease in prevalence of GABHS is seen with an higher Centor score. A possible explanation is the higher prevalence of viruses such as the Epstein-Barr virus, which also comes with fever, tonsillar excudate and swollen tender cervical lymph nodes. With a prevalence of GABHS which is constant, and comparable to overall population prevalence, for all different Centor categories in children from 5 to 16 years old it is clear that, in children, Centor criteria are not a good tool to assess the probability of GABHS. With a combined likelihood ratio (95% confidence interval) for Centor ≥ 3 of 0.67 (0.50 – 0.90) for the preschoolers and 1.37 (1.04 -1.79) for the kids, our results are in line with the results of the metaanalysis of Shaikh et al., who found a pooled LR (CI) for Centor ≥ 3 of 1.73 (1.28 – 2.35) [16].

Our results confirm that the Centor score is also insensitive to evaluate the absence of GABHS. In our group, children with less than 3 Centor criteria have a 72% probability for a negative culture for GABHS, which mirrors the average GABHS prevalence (30%) in this population [5, 21]. Even though the use of AB in streptococcal pharyngitis is disputed, physicians tend to have a low threshold to prescribe AB, judging only on clinical features, without knowing whether or not GABHS is the culprit (Roggen et al. unpublished data) [2]. Our results confirm that, at least in children, Centor criteria are an unreliable tool to assess the probability of the presence of GABHS, thus its use should be discouraged.

The strength of this study is the large number of children included. The major limitations of this study are the retrospective nature and the fact that not all children received a throat swab, thus introducing a selection bias, as children who had a throat swab had a higher Centor score.

Conclusion

Our results confirm the ineffectiveness of Centor criteria as a predicting factor for the presence or absence of GABHS in a throat swab culture in children from 2 to 15 years old.

Acknowledgements

The authors wish to thank Ms. Annemieke Verholle, who keeps the databases with patient information and ICD-9 codes up to date and Mr. André Van Zeebroeck who extracted the data from the laboratory of Microbiology.

Figures

Figure 1. Flow-chart showing the criteria for inclusion and exclusion.

Figure 2. Prevalence (%) of all 4 Centor criteria in children with respectively a GABHS positive and GABHS negative throat swab culture.

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Table 1. Centor criteria and presence of GABHS.

Number of criteria present	**<2**	**2**	**3**	**4**
Number of preschoolers (2-4 years)	33	96	113	44
GABHS prevalence (95% CI), %	45 (28-63)	33 (24-43)	23 (15-31)	13 (3-24)
Number of kids (5-15 years)	17	49	69	20
GABHS prevalence (95% CI), %	35 (10-61)	31 (17-44)	43 (31-55)	45 (21-69)

Table 2a. Correlation between clinical parameters and the presence of GABHS (2-4 years old).

Clinical parameter	Positive likelihood ratio (CI)	Negative likelihood ratio (CI)
Fever	0.87 (0.76 – 0.99)	1.91 (1.13 – 3.26)
Tonsillar exudate	0.67 (0.49 – 0.90)	1.48 (1.16 – 1.88)
Swollen lymph nodes	0.98 (0.77 – 1.25)	1.02 (0.77 – 1.35)
Absence of cough	0.85 (0.69 – 1.04)	1.35 (0.96 – 1.90)
Centor ≥ 3	0.67 (0.50 – 0.90)	1.50 (1.17 – 1.92)

Table 2b. Correlation between clinical parameters and the presence of GABHS (5-15 years).

Clinical parameter	Positive likelihood ratio (CI)	Negative likelihood ratio (CI)
Fever	0.96 (0.80 – 1.15)	1.13 (0.63 – 2.02)
Tonsillar exudate	0.91 (0.67 – 1.25)	1.10 (0.79 – 1.55)
Swollen lymph nodes	1.11 (0.82 – 1.51)	0.89 (0.63 – 1.26)
Absence of cough	1.30 (1.11 – 1.52)	0.33 (0.14 – 0.74)
Centor ≥ 3	1.37 (1.04 -1.79)	0.67 (0.45 – 0.99)

Title

Centor criteria in children in a pediatric emergency department: for what it's worth.

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Centor criteria in children.

Keywords

Sore throat, Centor criteria, Group A β Hemolytic Streptococcus, antibiotics policy

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Nothing to disclose.

Conflicts of interest

No conflicts of interests to disclose.

Contributor's Statement Page

Inge Roggen, Gerlant van Berlaer, Frans Gordts, Denis Pierard, Ives Hubloue fulfil all three of the ICMJE guidelines for authorship.

Article summary

Article focus

- To evaluate the correlation between Centor criteria and presence of GABHS in children with sore throat admitted to our emergency department, in order to evaluate the value of this prediction rule.

Key messages

- Results confirm the ineffectiveness of Centor criteria as a predicting factor for finding GABHS in a throat swab culture in children.

Strengths and limitations

- The strength of this study is the large number of children included. The major limitation is the fact that not all children received a throat swab, thus introducing a selection bias.

Abstract

Background

Centor criteria (fever > 38.5°C, swollen tender anterior cervical lymph nodes, tonsillar exudate and absence of cough) are an algorithm to assess the probability of Group A β Hemolytic Streptococcus (GABHS) as the origin of sore throat, developed for adults.

Objective

To evaluate the correlation between Centor criteria and presence of GABHS in children with sore throat admitted to our Pediatric Emergency Department.

Methods

Using a retrospective cohort study design, we analyzed all medical records (from 2008 to 2010) of children between the age of 2 and 16 years old, who were diagnosed with pharyngitis, tonsillitis or sore throat; had a throat swab culture for GABHS and had all four Centor criteria scored. Out of a total 2118 visits for sore throat, 441 met our criteria. The children were divided into two groups: 2-5 and 5-16 years old.

Results

The prevalence of GABHS was higher in the older children compared to the preschoolers (38.7 vs. 27.6; p=0.01), overall prevalence was 32%. There was no significant difference in prevalence of GABHS for all different Centor scores within an age group.

Likelihood ratio's (LR) demonstrate that none of the individual symptoms, nor a Centor score of ≥3 seems to be effective in ruling in or ruling out GABHS. Pooled LR (CI) for Centor ≥ 3 was 0.67 (0.50-0.90) for the preschoolers and 1.37 (1.04-1.79) for the older children.

Conclusion

Our results confirm the ineffectiveness of Centor criteria as a predicting factor for finding GABHS in a throat swab culture in children.

Introduction

In 1981 Centor et al. developed four criteria to predict the probability of the presence of Streptococcus pyogenes or Group A β Hemolytic Streptococcus (GABHS) in a throat swab culture [1]. When all four criteria (fever > 38.5°C, swollen tender anterior cervical lymph nodes, tonsillar exudate and absence of cough) are present, the probability of GABHS is just above 50%. When 2 or less criteria are present, the probability is below 15%. Hence, Centor criteria are often used as a tool to assess the absence of GABHS, rather than the presence [2, 3, 4]. It should also be noted that these criteria were specifically developed for adults [1]. More recently (2000) McIsaac et al. developed modified criteria, which add the age of the patient [5, 6] (+1 if age 3-14, 0 if age 15-44 and -1 if age ≥ 45), taking into account the fact that GABHS is more prevalent in the age group of 5 to 15 years [2, 7, 8, 9, 10]. Still several studies have shown that nor signs and symptoms, nor signs and symptoms combined as prediction rules, were reliable to distinguish between GABHS and non-GABHS pharyngitis [11, 12, 13, 14, 15, 16].

The administration of antibiotics used to be indicated, based on the incidence of non-suppurative complications (post-streptococcal glomerulonephritis and reactive arthritis) after streptococcal pharyngitis, but a large Cochrane review by Del Mar et al. [17] state that the use of antibiotics (AB), in otherwise healthy individuals, is no longer indicated, as not only the incidence of non-suppurative complications has disappeared in the developed world since the late 1960's but also because antibiotics will not shorten disease duration or symptoms [17, 18]. With the possibility of adverse effects of AB, the benefit to risk ratio is no longer in favor administering AB to otherwise healthy individuals with a streptococcal pharyngitis.

In our pediatric emergency department (PED), physicians are thought to follow the guidelines of the Belgian Antibiotic Policy Coordination Committee (BAPCOC). BAPCOC guidelines are based on the review by Del Mar et al [17]. And yet we found that in our PED, in 2009 and 2010, out of 1345 otherwise healthy children, 35% was prescribed AB (unpublished data). For general practitioners in Flanders, the prescription rate is as high as 50%, even without knowing whether or not the pharyngitis was caused by GABHS [2]. As many clinicians tend to rely on signs and symptoms, rather than on a strep test or throat swab culture, we wanted to evaluate the correlation between Centor criteria and presence of GABHS in children with sore throat admitted to our PED, in order to evaluate the value of this prediction rule.

Patients and methods

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All our records are digitalized and all diagnoses in our records are registered according to the International Statistical Classification of Diseases and Related Health Problems (ICD-9) codes. All files of children who received a throat swab for GABHS culture with the following ICD-9 codes infectious mononucleosis (075), nasopharyngitis (460), pharyngitis (462), tonsillitis (463) and sore throat (784.1) were included for analysis. Children with underlying chronic respiratory, cardiac, hematological or immunological diseases and children who already received antibiotics (AB) prior to the PED consult were excluded. Only records with full disease history were selected (figure 1).

We divided the patients into 2 groups: preschoolers (≥ 2 and < 5 years old) and kids (≥ 5 and < 16 years old), as the prevalence of GABHS is different in both groups.

Statistical analysis was performed using MedCalc® version 12.3.0 (MedCalc Software bvba, Mariakerke, Belgium). All data are presented as mean ± standard deviation (SD) or as median (range), when not normally distributed. D'Agostino-Pearson K-squared test was used for assessing normality of data. Spearman's rho test was used to calculate rank correlation coefficients.

Results

Out of all 2,118 PED visits for sore throat, 441 (230 boys - 211 girls) met our criteria (graph 1). Median age (range) was 5.0 years old (2.0 - 15.9). Median age (range) was respectively 3.3 years old (2.0 - 4.9) in the preschoolers (n=286) and 7.6 (5.0 - 15.9) in the kids (n=155). Throat swab culture for GABHS was positive for 32% of the patients. In kids, the prevalence of GABHS was higher compared to the preschoolers (38.7 vs. 27.6; p=0.01). Median age and gender distribution was not statistically significant between the included and excluded children.

The mean Centor score was similar between preschoolers and kids (2.6 ± 0.9 vs. 2.6 ± 0.9; p=0.8). The mean (95% confidence interval) presence of GABHS in our preschoolers was respectively: 45% (28-63%) with less than 2 Centor criteria present, 33% (24-43%) with 2, 23% (15-31%) with 3 and 13% (3-24%) with 4 criteria were present. In kids this was 35% (10-61%) when ≤ 1, 31% (17-44%) when 2, 43% (31-55%) when 3 and 45% (21-69%) when 4 criteria were present (table 1).

Preschoolers with a positive throat swab culture had significantly less often tonsillar exudate, compared to preschoolers (59 vs. 39%; p=0.003) or kids (55 vs. 39%; p=0.04) with a negative culture, but not compared to kids with a positive culture (50 vs. 39%; p=0.2). Kids with a positive throat swab culture did significantly more often present with an absence of cough, compared to all 3 other groups (p<0.05). The occurrence of all other symptoms did not differ significantly between all four groups (figure 2).

Likelihood ratio's (LR) for both age groups are shown in table 2a and 2b. Neither one of the individual symptoms, nor a Centor score of ≥ 3 seems to be effective in ruling in or ruling out GABHS.

We note that children included in our results (compared to those excluded) had more often tonsillar exudate (53.3 vs. 32.7%; p<0.0001), fever (81.6 vs. 74.4%; p=0.002) and swollen cervical lymph nodes (53.1 vs. 43.4%; p<0.05); and thus a higher Centor score (2.2 vs. 2.6; p<0.0001).

Discussion

Our results confirm the higher prevalence of GABHS in children between the ages of 5 and 15. The prevalence of GABHS in both our age groups is slightly higher compared to results in literature [5, 19, 20]. This is probably due to selection bias: not all children with a sore throat had a throat swab culture for GABHS and our physicians seem to have several different reasons on which they base their decision of whether or not taking a throat swab culture.

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Our results confirm that the Centor score is also insensitive to~~When it comes to evaluating~~ evaluate the absence of GABHS. ~~in~~ In our group, children with less than 3 Centor criteria have a 72% probability for a negative culture for GABHS~~., There were no differences between both age groups, which might be partly due to the observation that in the younger children there is a significantly higher reporting of fever (84.5 vs. 72.7%; p=0.004) and coughing is more often present (80.8 vs. 65.4%; p=0.004), resulting in a similar average Centor score for both age groups. Still, a 72% probability for a negative culture for GABHS which is very close to~~ mirrors the average GABHS prevalence (30%) in this population [5, 21]. ~~Thus, letting us conclude that Centor criteria are not a valid tool for assessing the absence of GABHS either.~~ Even though the use of AB in streptococcal pharyngitis is disputed, physicians tend to have a low threshold to prescribe AB, judging only on clinical features, without knowing whether or not GABHS is the culprit (Roggen et al. unpublished data) [2]. Our results confirm that, at least in children, Centor criteria are an unreliable tool to assess the probability of the presence of GABHS, thus it~~'~~s use should be discouraged.

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Our results confirm the ineffectiveness of Centor criteria as a predicting factor for the presence or absence of GABHS in a throat swab culture in children from 2 to 15 years old.

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Figures

Figure 1. Flow-chart showing the criteria for inclusion and exclusion.

Figure 2. Prevalence (%) of all 4 Centor criteria in children with respectively a GABHS positive and GABHS negative throat swab culture.

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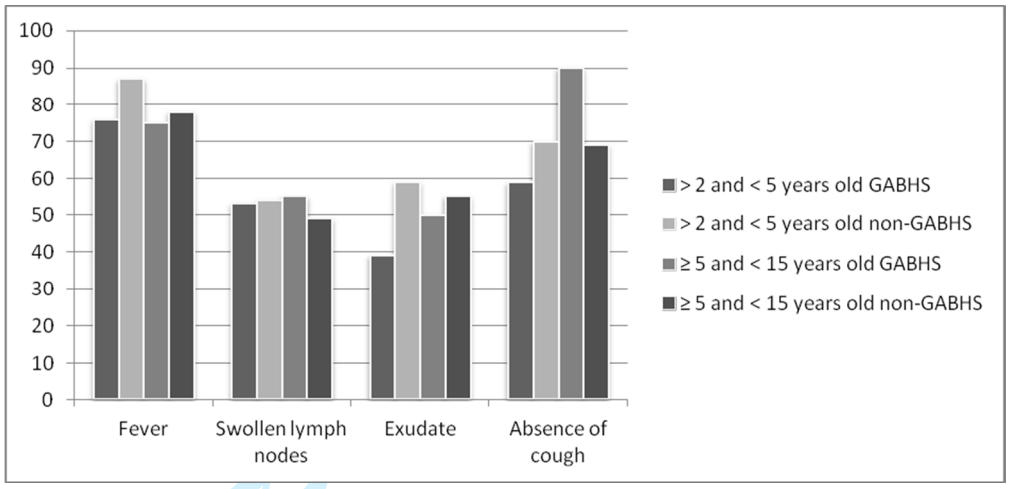
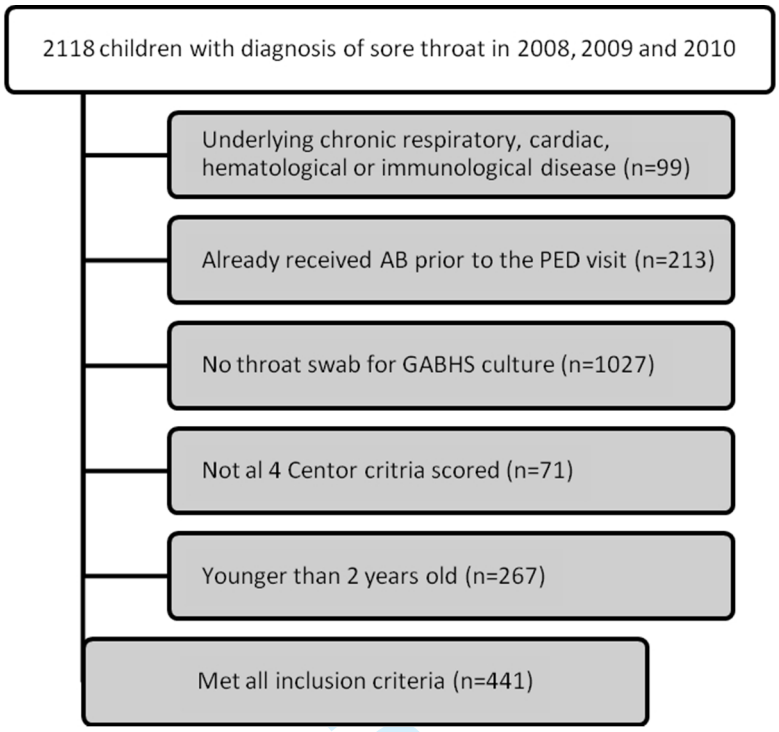
Table 2a. Correlation between clinical parameters and the presence of GABHS (2-4 years old).

Clinical parameter	Positive likelihood ratio (CI)	Negative likelihood ratio (CI)
Fever	0.87 (0.76 – 0.99)	1.91 (1.13 – 3.26)
Tonsillar exudate	0.67 (0.49 – 0.90)	1.48 (1.16 – 1.88)
Swollen lymph nodes	0.98 (0.77 – 1.25)	1.02 (0.77 – 1.35)
Absence of cough	0.85 (0.69 – 1.04)	1.35 (0.96 – 1.90)
Centor ≥ 3	0.67 (0.50 – 0.90)	1.50 (1.17 – 1.92)

Table 2b. Correlation between clinical parameters and the presence of GABHS (5-15 years).

Clinical parameter	Positive likelihood ratio (CI)	Negative likelihood ratio (CI)
Fever	0.96 (0.80 – 1.15)	1.13 (0.63 – 2.02)
Tonsillar exudate	0.91 (0.67 – 1.25)	1.10 (0.79 – 1.55)
Swollen lymph nodes	1.11 (0.82 – 1.51)	0.89 (0.63 – 1.26)
Absence of cough	1.30 (1.11 – 1.52)	0.33 (0.14 – 0.74)
Centor ≥ 3	1.37 (1.04 -1.79)	0.67 (0.45 – 0.99)





STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, explain how loss to follow-up was addressed
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Report numbers of outcome events or summary measures over time
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.