ORIGINAL ARTICLE
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UDC: 579.61::616.32-002.1-07
DOI: https://doi.org/10.2298/VSP260212026P

Diagnostic performance of the McIsaac score for group A streptococcal pharyngitis in children under three years of age

Dijagnostičke karakteristike McIsaac skora za streptokokni faringitis grupe A kod dece mlađe od tri godine

Momčilo Pavlović*, Karolina Berenji†, Željko Roković‡, Tatjana Ilić*§

***Children's Ambulatory Care Center Subotica, Subotica, Serbia; †Public Health Institute, Department of Hygiene and Human Ecology, Subotica, Serbia; ‡The College of Vocational Studies, Subotica, Serbia; §General Hospital Subotica, Pediatric Department, Subotica, Serbia**

Abstract

Background/Aim. Group A β-hemolytic streptococcus (GAS) pharyngitis most commonly affects school-aged children. The aim of this study was to assess the effectiveness and clinical applicability of the McIsaac score for diagnosing GAS pharyngitis in children under 3 years of age. **Methods.** The retrospective study included a total of 282 children under 3 years of age diagnosed with acute pharyngitis in a pediatric outpatient setting in Subotica, Serbia, between September 2023 and August 2024. Data on demographic and clinical characteristics were collected, including McIsaac score values. The obtained results were analyzed in relation to rapid antigen detection test (RADT) findings, which were performed on all children. **Results.** Of the total 282 children, 143 (50.7%) were RADT-positive. The McIsaac score demonstrated limited diagnostic accuracy, with sensitivity and specificity values for scores 0–2 of 69.9% and 38.1%, respectively, and for scores 3–4 of 30.7% and 61.9%, respectively. Receiver operating characteristic (ROC) curve analysis yielded an area under the curve (AUC) of 0.561. The absence of cough was the only individual McIsaac criterion significantly associated with a positive RADT result. **Conclusion.** The McIsaac score alone has limited effectiveness in identifying GAS pharyngitis in children under 3 years of age. Given the substantial symptom overlap between bacterial and viral infections in this age group, additional diagnostic methods are necessary to improve diagnostic accuracy.

Keywords:
child, preschool; diagnosis; infant; pharyngitis; rapid diagnostic tests; streptococcus pyogenes.

Apstrakt

Uvod/Cilj. Faringitis izazvan β-hemolitičkim streptokokom grupe A (*group A β-hemolytic streptococcus* – GAS) najčešće pogađa decu školskog uzrasta. Cilj rada bio je da se procene efikasnost i klinička primenljivost McIsaac skora u dijagnostikovanju faringitisa izazvanog GAS-om kod dece mlađe od 3 godine. **Metode.** Retrospektivnom studijom obuhvaćeno je 282 dece mlađe od 3 godine, kojima je postavljena dijagnoza akutni faringitis u pedijatrijskoj ambulanti u Subotici, Srbija, u periodu od septembra 2023. do avgusta 2024. godine. Prikupljeni su podaci o demografskim i kliničkim karakteristikama, uključujući vrednosti McIsaac skora. Dobijeni rezultati analizirani su u odnosu na nalaze brzog antigenskog testa (*rapid antigen detection test* – RADT), koji je urađen svakom detetu. **Rezultati.** Od ukupno 282 dece, 143 (50,7%) bilo je RADT pozitivno. McIsaac skor pokazao je ograničenu dijagnostičku tačnost, sa vrednostima osetljivosti i specifičnosti za rezultate 0–2 od 69,9% i 38,1%, redom, i za rezultate 3–4 od 30,7% i 61,9%, redom. Analizom *receiver operating characteristic* (ROC) krive dobijena je vrednost površine ispod krive (*area under the curve* – AUC) od 0,561. Odsustvo kašlja bio je jedini pojedinačni kriterijum McIsaac skora značajno povezan sa pozitivnim nalazom RADT-a. **Zaključak.** McIsaac skor, sam po sebi, ima ograničenu efikasnost u prepoznavanju GAS izazvanog faringitisa kod dece mlađe od 3 godine. S obzirom na značajno preklapanje simptoma bakterijskih i virusnih infekcija u ovoj uzrasnoj grupi, neophodne su dodatne dijagnostičke metode radi unapređenja tačnosti dijagnoze.

Ključne reči:
deca, predškolska; dijagnoza; odojče; faringitis; dijagnostički testovi, brzi; streptococcus pyogenes.

Correspondence to: Momčilo Pavlović, Children's Ambulatory Care Center Subotica, Šolohova 18, 24 000 Subotica, Serbia. E-mail: pavlovic.vsovsu@gmail.com

Introduction

Group A β-hemolytic streptococcus (GAS) pharyngitis is a prevalent clinical condition in primary pediatric care, most commonly affecting school-aged children. Previous studies have reported that GAS accounts for 15–30% of all pharyngitis cases in this population [1, 2]. However, there is an ongoing debate regarding the optimal strategies for diagnosis, treatment, and avoiding the associated complications of GAS pharyngitis [3]. Accurate diagnosis typically relies on rapid antigen detection tests (RADTs) or throat cultures [4]. Despite the clinical challenges in diagnosing GAS pharyngitis, the necessity of microbiological confirmation varies across different guidelines. The decision to test should take into account clinical signs and symptoms, the patient's age, seasonality, and exposure to individuals with confirmed GAS infection [3–5].

Treatment with antibiotics may shorten the clinical course by up to 16 hrs, reduce transmission, prevent suppurative complications, and reduce the risk of non-suppurative immune-mediated diseases of GAS pharyngitis [6–8].

To aid in the estimation of GAS pharyngitis probability, the Centor and McIsaac scores were developed. The Centor score (ranging from 0 to 4) evaluates four clinical criteria: tonsillar exudate, swollen tender anterior cervical lymph nodes, fever (temperature > 38 °C), and absence of cough [9]. While the Centor score was originally designed for adults, the McIsaac score incorporated additional variables, such as age, to enhance its applicability in pediatric populations, with particular emphasis on tonsillar findings, including exudate or enlargement, as clinically relevant features in pediatric assessment [10]. The McIsaac score (ranging from -1 to 5) assigns points based on clinical findings, with one additional point for patients aged 3–14 years and one point subtracted for those aged 45 years or older.

Diagnosing GAS pharyngitis in children under three years of age is particularly challenging because of the substantial overlap of symptoms with viral upper respiratory infections (URIs). Because clinical manifestations are often nonspecific, relying solely on epidemiological and clinical findings may be insufficient, even for experienced clinicians [11]. In children under three years of age, GAS infections may present atypically, sometimes referred to as streptococcosis, with persistent nasal congestion, low-grade fever, and anterior cervical lymphadenopathy. In infants, symptoms are often nonspecific, manifesting as mild fever, irritability, and reduced feeding [12]. This symptomatic overlap diminishes the effectiveness of the McIsaac score in differentiating bacterial from viral etiologies, thereby increasing the risk of both false-positive and false-negative results.

The aim of this study was to evaluate the effectiveness of the McIsaac score for diagnosing GAS pharyngitis as well as its applicability in children under three years of age.

Methods

A retrospective, single-center cohort study was conducted at the Children's Ambulatory Care Center Subotica, Subotica, Serbia, a primary care facility, from September 1, 2023, to August 31, 2024. The study included children under three years of age diagnosed with acute pharyngitis, regardless of the presence of tonsillar swelling or exudate, fever, cervical lymphadenopathy, or cough. Additional symptoms, such as rhinorrhea, vomiting, abdominal pain, and diarrhea, were recorded but were not included in the scoring criteria. Children exhibiting rales, wheezing, or respiratory distress indicative of lower respiratory tract disease, as well as those diagnosed with otitis media, were excluded. Patients who had received systemic antibiotics within the prior 10 days were also excluded from the study.

The study was approved by the Ethics Committee of the Children's Ambulatory Care Center Subotica (No. 3/2023, from August 07, 2023).

The McIsaac score (ranging from 0 to 4) was calculated using four clinical parameters, each contributing one point: tonsillar swelling or exudate, tender or swollen anterior cervical lymph nodes, fever, and absence of cough [10]. As all participants were younger than three years of age, the age-related component of the original McIsaac score was not applicable. Fever was defined as a temperature > 38 °C. Cervical lymph nodes were classified as abnormal if they were either swollen (> 1 cm in diameter) without tenderness or palpable with tenderness.

All study participants underwent RADT for GAS infection. The tests were administered by trained nurses following the manufacturer's guidelines, and results were promptly reported to the attending physician. Pharyngeal specimens were collected by swabbing both tonsillar surfaces and the posterior pharyngeal wall using a sterile cotton-tipped swab. The QuikRead go® Strep A test (Orion Diagnostica Oy, Espoo, Finland) was utilized for detecting *Streptococcus pyogenes* in throat samples. This test operates in conjunction with the QuikRead go instrument, an automated device for quantitative and qualitative measurements using a turbidimetric method.

The relationship between the McIsaac criteria and RADT results was analyzed.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 29.0.1.1 (IBM Corporation, USA, 2024). Categorical variables were expressed as absolute numbers and percentages and compared using Pearson's Chi-squared test or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), negative likelihood ratio (LR-), and overall accuracy were calculated for each McIsaac criterion and score among RADT-positive children. RADT results served as the reference standard for these calculations.

Results

A total of 282 patients were enrolled (mean age ± standard deviation: 22.6 ± 6.7 months), of whom 143 (50.7%) tested positive on RADT and 139 (49.3%) tested negative. The study population included 173 (61.4%) males and 109 (38.6%) females, with the youngest RADT-positive

child being 6.5 months old. Age distribution and overall GAS infection prevalence were summarized in Table 1.

No statistically significant correlation was observed between RADT positivity and clinical indicators such as tonsillar swelling/exudates, temperature > 38 °C, or swollen anterior cervical lymph nodes. Among the McIsaac criteria, absence of cough was the only parameter showing a statistically significant association with RADT positivity. McIsaac scores ranging from 1 to 4 did not demonstrate a meaningful correlation with the presence of GAS pharyngitis. Furthermore, no significant relationships were identified between GAS pharyngitis and additional symptoms, including rhinorrhea, vomiting, abdominal pain, or diarrhea (Table 2).

The receiver operating characteristic (ROC) curve for RADT-positive patients demonstrated an area under the curve (AUC) of 0.561. The McIsaac score's validity was further assessed, yielding an asymptotic significance of 0.072 and a 95% confidence interval of 0.494–0.628 (Figure 1).

Table 1

Age distribution of children with acute pharyngitis according to RADT results (n = 282)

Patients	RADT-positive	RADT-negative	Total
Age group, months			
0–11.9	9 (47.4)	10 (52.6)	19 (6.7)
12–23.9	76 (51.4)	72 (48.6)	148 (52.5)
24–35.9	58 (50.4)	57 (49.6)	115 (40.8)
All patients	143 (50.7)	139 (49.3)	282 (100)

RADT – rapid antigen detection test; n – number.
All values are given as numbers (percentages).

Table 2

Clinical indicators and their association with RADT positivity (n = 282)

Clinical manifestations	RADT-positive (n = 143)	RADT-negative (n = 139)	*p*-value
Tonsillar swelling or exudate	64 (50.8)	62 (49.2)	0.886*
Fever (temperature > 38 °C)	121 (50.8)	117 (49.2)	0.601*
Absence of cough	118 (48.2)	127 (51.8)	**0.033***
Cervical node enlargement	9 (56.2)	7 (43.8)	0.648*
Rhinorrhea	55 (52.4)	50 (47.6)	0.497*
Gastrointestinal symptoms (vomiting, abdominal pain, diarrhea)	34 (47.2)	38 (52.8)	0.493*
McIsaac score			
0–1	25 (64.1)	14 (35.9)	0.072*
2	75 (51.0)	72 (49.0)	0.913*
3	41 (45.0)	50 (55.0)	0.190*
4	2 (40.0)	3 (60.0)	0.681**

RADT – rapid antigen detection test; n – number.
All values are given as numbers (percentages).
***Note:* * Pearson's Chi-squared test; ** Fisher's exact test. Values that differ significantly ($p < 0.05$) are marked in bold.**

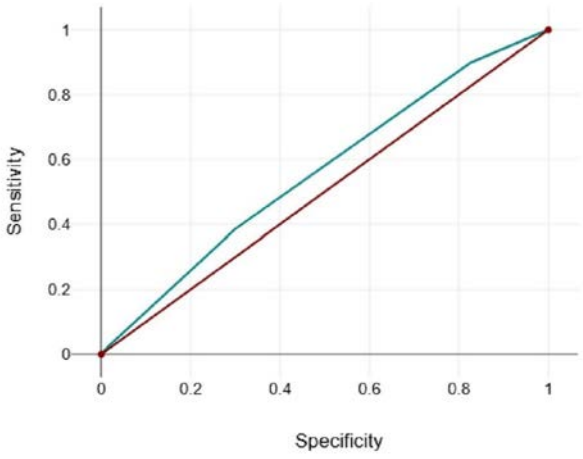

Fig. 1 – Receiver operating characteristic (ROC) curve of McIsaac criteria.
***Note:* Diagonal segments are produced by ties. The blue line represents the ROC curve, while the red line represents the reference diagonal (line of no discrimination, area under the curve – AUC = 0.5).**

Table 3

Evaluation of McIsaac criteria using RADT confirmation

McIsaac criteria and scores	Sensitivity, %	Specificity, %	PPV, %	NPV, %	Ac, %	LR+	LR-
Tonsillar swelling or exudate	45.4	55.0	50.9	49.5	50.1	1.0	0.9
Fever (temperature > 38 °C)	71.3	26.0	48.5	32.4	46.1	0.9	2.0
Absence of cough	82.5	8.6	48.1	32.4	46.0	0.9	2.0
Cervical node enlargement	6.2	94.9	56.2	49.6	50.1	1.2	0.9
McIsaac score							
0–2	69.9	38.1	53.8	55.2	54.3	1.1	0.7
3–4	30.7	61.9	44.8	46.2	45.7	0.7	1.1

RADT – rapid antigen detection test; PPV – positive predictive value; NPV – negative predictive value; Ac – overall accuracy; LR+ – positive likelihood ratio; LR- – negative likelihood ratio.

The diagnostic performance of McIsaac scores compared with RADT results is summarized in Table 3. For McIsaac scores 0–2, sensitivity was 69.9%, specificity 38.1%, PPV 53.8%, NPV 55.2%, LR+ 1.1, LR− 0.7, and overall accuracy 54.3%. In contrast, for McIsaac scores 3–4, sensitivity was 30.7%, specificity 61.9%, PPV 44.8%, NPV 46.2%, LR+ 0.7, LR− 1.1, and overall accuracy 45.7%.

Discussion

In this retrospective study, McIsaac scores did not demonstrate a significant association with RADT positivity in children under three years of age with acute pharyngitis. The predictive validity of the McIsaac score, as assessed by AUC, was low, indicating limited effectiveness in distinguishing between positive and negative cases. Unexpectedly, the highest proportion of RADT-positive cases occurred in children with McIsaac scores of 0–2. For this group, sensitivity was 69.9% and specificity was 38.1%, highlighting the score's limited ability to differentiate between positive and negative cases. Conversely, the lowest proportion was found in children with McIsaac scores of 3 and 4 (sensitivity 30.7%, specificity 61.9%), suggesting poor performance in identifying true positive cases. This unexpected observation may be due to the atypical presentation of GAS pharyngitis in young children, where symptoms frequently resemble those of URIs. It is also possible that co-existing viral infections or underlying immune responses influenced these results. No significant differences in RADT positivity rates were observed across the various McIsaac score groups.

The poor performance of each McIsaac variable warrants further discussion. Previous cohort studies have quantified the frequency of respiratory infections in infants under two years, with an average of 3–6 infections *per* year and a 95th percentile reaching up to 11 infections annually [13, 14]. This equates to approximately one respiratory infection *per* month, with increased prevalence in winter. Given that URIs in children under three typically last 10–15 days, symptoms such as cough are unreliable indicators for distinguishing GAS pharyngitis from viral infections [13]. Nevertheless, our study found an association between GAS pharyngitis and the absence of cough, which aligns with prior research suggesting that cough is more indicative of viral infections, whereas its absence is more specific to GAS pharyngitis [15].

Palpable cervical lymph nodes are frequently observed in young children, with reported prevalence rates of 45–57% due to immune system development [16]. However, younger children may struggle to articulate pain, making tender anterior cervical lymphadenopathy a less reliable diagnostic marker [17]. Similarly, fever, commonly seen in both bacterial and viral infections, does not effectively differentiate etiology or indicate illness severity [18]. A study has shown that hyperpyrexia does not necessarily correlate with a higher probability of bacterial infections over viral ones [19]. In our cohort, elevated temperature had low sensitivity and specificity, reinforcing its limitations as a diagnostic criterion for GAS pharyngitis.

Various clinical scoring systems have been designed to assess GAS pharyngitis risk and guide diagnosis and treatment. A 2021 systematic review of 36 guidelines across 26 countries revealed that most clinical recommendations are based on symptomatology and age-based assessments, such as the Centor and McIsaac scores [20]. A meta-analysis examining 16 distinct scoring methods concluded that no single tool provides sufficient specificity for pediatric cases, emphasizing the need for further testing in high-risk children [21]. A 2024 systematic review of 14 studies (8 on McIsaac and 6 on Centor) concluded that neither score was sufficiently effective for triaging pediatric pharyngitis cases requiring antibiotics [22]. Although some previous studies included a limited number of children under three years of age, these youngest patients were grouped with older children and were not analyzed separately [21, 22]. To the best of our knowledge, this is the first study to specifically evaluate the validity of the McIsaac score exclusively in children under three years of age, thereby addressing an important gap in the existing literature.

Half of the children with acute pharyngitis in our study tested positive for RADTs, suggesting that GAS infections in young children may be more common than previously thought. Early studies with immune response-confirmed diagnoses reported GAS prevalence rates below 10% in this age group [23, 24]. However, a 2010 meta-analysis estimated that up to 26% of children under five years of age with sore throat could have GAS pharyngitis [25]. A large-scale Portuguese study in 2021, including 3,128 children under three, found GAS prevalence rates of 18% in infants under one year, 27% in children under two years, and 34% in those under three years of age [26].

Previous studies highlight the risk of diagnostic errors with RADTs [27, 28]. Stefaniuk et al. [27] reported 14% false-positive and 8% false-negative rates (PPV 83%, NPV 92%), while Azrad et al. [28] observed up to 20% false-positive and 5% false-negative results (specificity 73.3%, sensitivity

80%). These findings underscore the inherent potential for both false-positive and false-negative outcomes. Furthermore, some children in the study may have been asymptomatic GAS carriers rather than experiencing active infections, as epidemiological research from Serbia estimates GAS carriage rates in healthy children to range between 5.5% and 11.4% [29]. Currently, there is no reliable method to differentiate between acute GAS pharyngitis and asymptomatic GAS carriage in children with concurrent viral pharyngitis [30]. Future research could focus on developing molecular or biomarker-based diagnostic tools to distinguish between these conditions, potentially improving the overall accuracy of clinical decisions.

Limitation of the study

The primary limitation of this study is its retrospective nature. However, the McIsaac scores were derived from patient records, and RADTs were independently administered by nurses without access to clinical details, minimizing bias. Furthermore, this research was conducted at a single institution, potentially limiting the generalizability of findings.

Conclusion

Due to the diverse clinical manifestations of pharyngitis caused by group A β-hemolytic streptococcus in early childhood, the McIsaac score alone is insufficient for reliable diagnosis in children under three years of age. Our study demonstrated that the prevalence of infections caused by group A β-hemolytic streptococcus in this age group is higher than previously reported. Although further prospective studies are needed, clinicians should remain vigilant and consider group A β-hemolytic streptococcus pharyngitis even when the symptoms closely resemble viral upper respiratory tract infections.

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Received on February 12, 2026
Revised on April 8, 2026
Accepted on April 29, 2026
Online First May 2026