

Nasopharyngeal Isolates from a Cohort of Medical Students with or without Pharyngitis

Hassib Narchi, Junu V. George, Sania M. Al-Hamad, Fawaghi Robari, Mariam Al-Teniji, Hussain Chaqfa, Ahmed Alsuwaidi, *Lolowa Al-Mekhaiini, Abdul-Kader Souid

عزلات البلعوم الأنفي لمجموعة من طلاب الطب مصابين أو غير مصابين بالتهاب البلعوم

حسيب نارشي، جونو فازبولي جورج، سانيه مازن الحمد، فواغي روبراري، مريم الطنجي، حسام شقفة، أحمد السويدي، لولوة المخيني، عبدالقادر سويد

ABSTRACT: Objectives: Few studies have investigated pharyngeal colonisation in the United Arab Emirates (UAE). This study aims to identify the pharyngeal organisms present in a cohort of medical students with and without symptomatic pharyngitis. **Methods:** This study was conducted between September 2016 and June 2018 at the College of Medicine and Health Sciences, UAE University, Al-Ain. Nasopharyngeal swabs were collected from preclinical and clinical medical students attending the college during the study period. The specimens were tested for 16 viral and nine bacterial pathogens using a real-time polymerase chain reaction assay. **Results:** A total of 352 nasopharyngeal swabs were collected from 287 students; of these, 22 (7.7%) had pharyngitis symptoms. Overall, the most common isolates were human rhinovirus, *Streptococcus pneumoniae* and *Haemophilus influenzae*, with no significant differences in terms of gender, year of study or stage of study. The prevalence of *S. pyogenes* in asymptomatic and symptomatic students was 1.1% and 0%, respectively. A Centor score of ≥ 2 was not associated with *S. pyogenes*-positive samples. Six pathogens were isolated from symptomatic students including *H. influenzae*. *Fusobacterium necrophorum* was not detected in any of the samples. **Conclusion:** The diagnosis and management of pharyngitis should be tailored to common pathogens in the region. This study found that *S. pyogenes* and *F. necrophorum* were not detected among students with symptoms of pharyngitis; moreover, Centor scores of ≥ 2 were not associated with the presence of *S. pyogenes*. This cut-off score therefore should not be employed as an empirical measure to initiate penicillin therapy in this population.

Keywords: Pharyngitis; Pharynx; Asymptomatic Infections; Carrier State; *Fusobacterium necrophorum*; *Streptococcus pyogenes*; Penicillins; United Arab Emirates.

المخلص: الهدف: الدراسات التي قامت ببحث الكائنات الدقيقة التي تستوطن البلعوم في الإمارات العربية المتحدة قليلة. هدفت هذه الدراسة الى التعرف على الكائنات البلعومية الموجودة لدى مجموعة من طلاب الطب المصابين بالتهاب البلعوم المصحوب بأعراض وغير المصحوب بأعراض الطريقة: أجريت هذه الدراسة في الفترة ما بين سبتمبر 2016 ويونيو 2018 في كلية الطب والعلوم الصحية، جامعة الإمارات العربية المتحدة، مدينة العين. تم جمع مسحات البلعوم الأنفي من طلاب الطب للمرحلة السريرية وما قبلها الملتحقين بالكلية خلال فترة الدراسة. تم اختبار العينات لـ 16 من مسببات الأمراض الفيروسية و 9 مسببات بكتيرية باستخدام اختبار تفاعل البلمرة المتسلسل اللحظي. النتائج: تم جمع 352 مسحة بلعومية أنفية من 287 طالباً؛ حيث أن 22 (7.7%) من هؤلاء الطلاب لديهم أعراض التهاب البلعوم. بشكل عام كانت العزلات الأكثر شيوعاً هي للفيروس الأنفي البشري، والبكتيريا العقدية الرئوية والبكتيريا المستدمية النزلية، مع عدم وجود فروق ذات دلالة إحصائية من حيث الجنس أو سنة الدراسة أو مرحلة الدراسة. كان مدى انتشار البكتيريا العقدية المقيحة في الطلاب الذين لا يعانون من أعراض أو لديهم أعراض هو 1.1% و 0% على التوالي. لم تتوافق درجة "سنتور" (معياري تشخيص العدوى البكتيرية العقدية) البالغة ≥ 2 مع عينات البكتيريا العقدية المقيحة الإيجابية. تم عزل ستة من مسببات الأمراض من الطلاب الذين ظهرت عليهم الأعراض، بما في ذلك المستدميات النزلية. لم يتم الكشف عن البكتيريا المغزلية المنخرية في أي من العينات الخالصة؛ يجب أن يكون تشخيص التهاب البلعوم وعلاجه متناسباً مع مسببات الأمراض الشائعة في المنطقة. وجدت هذه الدراسة أن البكتيريا العقدية المقيحة والبكتيريا المغزلية المنخرية لم يتم اكتشافهما بين الطلاب المصابين بأعراض التهاب البلعوم. علاوة على ذلك، لم تتوافق درجات "سنتور" البالغة ≥ 2 مع وجود البكتيريا العقدية المقيحة. تشير هذه النتيجة الحدية إلى أنه لا ينبغي استخدام درجات "سنتور" كإجراء تجريبي لبدء العلاج بالبنسلينات في هذه الفئة من السكان.

الكلمات المفتاحية: التهاب البلعوم؛ بلعوم؛ علم الأحياء الدقيقة؛ إصابات عدوية الأعراض؛ حالة الناقل؛ البكتيريا المغزلية المنخرية؛ البكتيريا العقدية المقيحة؛ البنسلينات؛ الاستخدام العلاجي؛ الإمارات العربية المتحدة.

ADVANCES IN KNOWLEDGE

- This study yielded unexpected results that challenge the findings of previous research regarding the use of the Centor score to predict the presence of *Streptococcus pyogenes* in cases of pharyngeal infection.
- Specifically, the assessment of nasopharyngeal isolates from a cohort of medical students with and without symptomatic pharyngitis indicated little difference in the prevalence of *S. pyogenes*; moreover, Centor score was not associated with the presence of this organism.

APPLICATION TO PATIENT CARE

- Current management guidelines for the treatment of pharyngitis in medical students from the United Arab Emirates should be reconsidered in light of these findings.

CURRENT DIAGNOSTIC AND MANAGEMENT guidelines for pharyngitis focus exclusively on *Streptococcus pyogenes* and are designed to decrease the duration of symptoms and lower the risk of complications.¹⁻⁴ The Centor criteria are a set of clinical criteria used to predict the probability that a patient has streptococcal pharyngitis with a cut-off score of ≥ 2 recommended for clinical decision-making when initiating antibiotic therapy.⁵⁻⁹ However, other *streptococci* can also cause bacterial pharyngitis, such as *Mycoplasma pneumoniae* and *Fusobacterium necrophorum*.¹⁰⁻¹² Among adolescents and young adults, the latter species causes at least 10% of all pharyngitis cases and is the most common cause of peritonsillar abscesses and Lemierre syndrome.^{1,12-13} Thus, standard antibiotic therapy for pharyngitis may be inadequate in cases arising due to organisms other than *S. pyogenes*.¹⁴

As such, it is imperative that the prevalence of other viral and bacterial organisms in patients with pharyngitis is assessed in order to guide the management of these infections. However, relatively few studies from the United Arab Emirates (UAE) have assessed causative agents of pharyngitis in this region, with previous research focusing instead on rapid tests to detect *S. pyogenes*.¹⁵ Therefore, this study aimed to elucidate patterns of nasopharyngeal colonisation in a cohort of medical students with or without symptoms of pharyngitis, evaluate the performance of the Centor score in the diagnosis of *S. pyogenes*-caused pharyngitis and determine the prevalence of *F. necrophorum* in this population.

Methods

This prospective descriptive study was conducted between September 2016 and June 2018 at the College of Medicine and Health Sciences, UAE University, Al-Ain. During this time, there were 539 medical students enrolled in the college, of which 412 (76.4%) were female. The required sample size was calculated to be 200 participants, based on a 1.1–20% prevalence rate of pathogens and to give the study adequate power at a 95% confidence interval and a precision of 1%.¹⁷ However, to allow for the loss of up to 20% of the participants as a result of incomplete information, at minimum of 240 participants were targeted. Both preclinical (years one to four) and clinical (years five

and six) students were included as the latter were deemed at higher risk of colonisation due to frequent contact with patients. Students were excluded if they were currently taking or had completed a course of antibiotics within the preceding four-week period.

The participants completed a questionnaire to determine their age, gender, year of study and the presence of any symptoms of pharyngitis. Subsequently, a clinical examination was conducted for those who reported symptoms of pharyngitis to determine the presence of any fever (a temperature of $\geq 38^\circ\text{C}$), tonsillar enlargement with exudates, tenderness of the anterior cervical lymph nodes and the absence of a cough, in accordance with the revised Centor criteria.^{9,16} For the purposes of the study, a Centor score of one point assigned to each of the aforementioned criteria. All of the participants were instructed to report to the research nurse if they developed symptoms of pharyngitis before beginning antibiotic treatment. Affected students were subsequently advised to report to their primary physician for management.

Nasopharyngeal samples were collected from each participant using eNaT[®] swabs (Copan Italia SpA, Brescia, Italy), as per the manufacturer's instructions. A registered nurse collected the specimens while wearing appropriate personal protective equipment. After the procedure was explained, the student was asked to sit in a chair with their head tilted back to approximately 70° . The sample collection pouch was opened and the cap was unscrewed and removed before removing the swab. The shaft of the swab was then gently inserted into one nostril and pressure was applied until it reached the posterior *nares*, where it was left in place for a few seconds before being removed. Subsequently, excess fluid was extracted by pressing the swab against the inside of the vial. The end of the shaft was then bent at a 180° angle at the breakpoint mark to break it off against the rim of the tube. The broken handle was discarded and the cap was replaced and secured tightly. An identification label was placed on the sealed tube before it was sent to the laboratory for storage at -80°C until analysis.

Total nucleic acid was isolated from the nasopharyngeal swabs using the STARMag universal cartridge kit (Seegene Inc., Seoul, Korea) and then extracted using the Microlab[®] Nimbus automated workstation (Hamilton Company, Reno, USA).

Subsequently, the presence of common pathogenic organisms was detected via multiplex one-step real-time polymerase chain reaction (PCR) analysis using the Allplex™ respiratory full-panel assay (Seegene Inc.). A total of 16 viruses were targeted, including influenza (subtypes A, B, A-H1, A-H1pdm09 and A-H3), parainfluenza (subtypes 1–4), respiratory syncytial virus (RSV; subtypes A and B), adenovirus, human enterovirus, human metapneumovirus, human bocavirus, human rhinovirus and coronaviruses (subtypes NL63, 229E and OC43). In addition, the presence of seven bacterial pathogens was assessed including *S. pneumoniae*, *Haemophilus influenzae*, *M. pneumoniae*, *Chlamydia pneumoniae*, *Legionella pneumophila*, *Bordetella pertussis* and *B. parapertussis*. Previously published primer/probe sets were also used to detect DNA from *F. necrophorum* (based on the *gyrase subunit B* gene) and *S. pyogenes* (based on the *streptococcal proteinase B* gene).¹⁹

Each reaction contained 9µL of template DNA and was assayed in duplicate in 20 µL reactions containing 1 × final concentration of the TaqMan® universal master mix (Applied Biosystems, Foster City, California, USA), 18 µM of each primer and 5 µM of the probe. All reactions were accompanied by the relevant positive and negative controls. The amplification and detection of *F. necrophorum* DNA was performed on a 7500 Fast Real-Time PCR System (Applied Biosystems) using the following reaction conditions: three minutes at 95°C, 40 cycles of 20 seconds at 95°C, one minute at 55°C and 15 seconds at 72°C. Moreover, *S. pyogenes* was assayed similarly with the following cycle conditions: three minutes at 95°C, 40 cycles of 20 seconds at 95°C, one minute at 58°C and 15 seconds at 72°C. The cycle threshold (Ct) was calculated using automated settings, with a Ct value of <40 considered positive. Negative results were accepted when the internal control had a Ct value of <40. Colonisation profiles were then compared between asymptomatic students and those with pharyngitis.

The statistical analysis was performed using Stata® data analysis and statistical software, Version 14.0 (StataCorp LLC, College Station, Texas, USA). For the purposes of the analysis, exposure was defined as the isolated pathogen, while the outcome was the presence or absence of pharyngitis (defined as a sore throat). Prevalence rates and 95% confidence intervals (CIs) of each pathogen were calculated for both symptomatic and asymptomatic students. In addition, the crude odds ratio (OR) and 95% CI of developing symptomatic pharyngitis was calculated for the most commonly identified organisms. A logistic regression model was used to determine corresponding OR and 95% CI values adjusted for potential confounders (i.e.

gender, age and year of study). For pathogens that were not isolated, the upper 95% CI limit of the probability of events which had not occurred was calculated as 3/n or 3/352.¹⁷ The degree of association between Centor score (using a cut-off score of ≥2) and the most common pathogens was determined using Chi-squared or Fisher's exact tests. A two-tailed P value of <0.050 was deemed statistically significant.

Ethical approval for this study was granted by the Al Ain Medical District Human Research Ethics Committee (#ERH-2015-323915-110). Informed consent was obtained from all of the participants prior to their inclusion in the study. All procedures were conducted in accordance with the ethical standards of the revised Declaration of Helsinki.

Results

A total of 287 students participated in the study; of these, 69% were female. The median age was 20 years (range: 17–30 years old). There were 22 students (7.7%), with 26 samples, who had symptoms of pharyngitis, with tender cervical lymphadenopathy being most common (63.6%) and fever the least common (9.1%). No significant differences were observed between the two groups in terms of age, gender, year of study or stage of study (i.e. between preclinical and clinical students) [Table 1].

Overall, 352 nasopharyngeal samples were collected, with 32 students (11.1%) being sampled more than once. Of these, 42 samples were positive for at least one viral pathogen (11.9%, 95% CI: 8.7–15.7%) and 19 were positive for at least one bacterial isolate (5.4%, 95% CI: 3.3–8.3%). The most common isolates were rhinovirus (7%, 95% CI: 5–11%), *H. influenzae* (3%, 95% CI: 1–4%) and *S. pneumoniae* (2%; 95% CI: 1–4%). The prevalence rate of *S. pyogenes* was 0.5% (95% CI: 0.1–2%) with positive samples found only in three asymptomatic participants. *F. necrophorum* was not isolated in any of the samples. There were no differences in the prevalence rates of the different isolates according to gender, year of study or stage of study.

Among the 326 samples collected from 265 asymptomatic students, carriage rates were 7.5% (95% CI: 4.6–11.4%) for rhinovirus, 2.3% (95% CI: 1.7–2.8%) for *H. influenzae*, 1.5% (95% CI: 0.4–3.8%) for *S. pneumoniae* and 1.1% (95% CI: 0.2–3.2%) for *S. pyogenes*. For symptomatic students, these rates were respectively 27.3% (95% CI: 10.7–50.2%), 13.6% (95% CI: 12.9–34.9%) and 0% (upper 97.5% CI: 15.4%). No pathogens were isolated from 15 of the 22 symptomatic students (68.2%, 95% CI: 45.1–86.16%) [Table 2].

Table 1: Characteristics of medical students with or without symptoms of pharyngitis (N = 287)

Characteristic	n (%)		P value*
	Asymptomatic (n = 265)	Symptomatic (n = 22)	
Gender			0.572
Female	184 (69.4)	14 (63.6)	
Male	81 (30.6)	8 (36.4)	
Mean age in years \pm SD	19.8 \pm 2.1	20.2 \pm 2.0	0.530
Year of study			0.761
1	80 (30.2)	5 (22.7)	
2	51 (19.2)	6 (27.3)	
3	26 (9.8)	3 (13.6)	
4	32 (12.1)	1 (4.5)	
5	60 (22.4)	6 (27.3)	
6	16 (6.0)	1 (4.5)	
Stage of study			0.755
Preclinical	189 (71.3)	15 (68.8)	
Clinical	76 (28.7)	7 (31.8)	
Year of collection			0.755
2016	36 (13.6)	2 (9.1)	
2017	192 (72.5)	16 (72.7)	
2018	37 (14)	4 (18.2)	
Month of collection			0.056
January	19 (7.2)	1 (4.5)	
February	27 (10.2)	2 (9.1)	
March	52 (19.6)	6 (27.3)	
April	5 (1.9)	3 (13.6)	
September	71 (26.8)	3 (13.6)	
October	15 (5.7)	1 (4.5)	
December	76 (28.7)	6 (27.3)	

SD = standard deviation. *Calculated using a t-test for continuous variables and a Chi-squared test or Fisher's exact test for proportional values, as appropriate.

For the three most common pathogens, the crude ORs for their isolation from symptomatic versus asymptomatic participants were 4.3 (95% CI: 1.5–12.2; $P = 0.002$) for rhinovirus, 4.4 (95% CI: 0.8–23.4; $P = 0.054$) for *H. influenzae* and 8.4 (95% CI: 1.8–38.2; $P = 0.001$) for *S. pneumoniae*. The adjusted ORs were 4.8 (95% CI: 1.7–13.7; $P = 0.003$), 4.0 (95% CI: 0.7–22.8; $P = 0.112$) and 8.5 (95% CI: 1.8–38.8; $P = 0.006$), respectively. The OR for *S. pyogenes* remained at zero as it was only identified in three asymptomatic

Table 2: Pathogens isolated among medical students with or without symptoms of pharyngitis (N = 287)

Pathogen*	n (%)		P value†
	Asymptomatic (n = 265)	Symptomatic (n = 22)	
Rhinovirus	20 (7.5)	6 (27.3)	0.008
<i>Haemophilus influenzae</i>	6 (2.3)	2 (9.1)	0.119
<i>Streptococcus pneumoniae</i>	4 (1.5)	3 (13.6)	0.011
Parainfluenza virus 3	3 (1.1)	0 (0)	1.000
Metapneumovirus	3 (1.1)	0 (0)	1.000
<i>S. pyogenes</i>	3 (1.1)	0 (0)	1.000
Influenza A-H3 virus	3 (1.1)	0 (0)	1.000
Influenza A-H1 virus	2 (0.8)	0 (0)	1.000
<i>Legionella pneumophila</i>	2 (0.8)	0 (0)	1.000
Influenza A virus	1 (0.4)	0 (0)	1.000
Influenza A-H1pdm09	1 (0.4)	0 (0)	1.000
Parainfluenza virus 1	1 (0.4)	0 (0)	1.000
Parainfluenza virus 4	1 (0.4)	0 (0)	1.000
Bocavirus	1 (0.4)	0 (0)	1.000
Coronavirus OC43	1 (0.4)	0 (0)	1.000
<i>Chlamydomphila pneumonia</i>	1 (0.4)	0 (0)	1.000
<i>Bordetella pertussis</i>	1 (0.4)	0 (0)	1.000
Coronavirus NL63	1 (0.4)	1 (4.5)	0.048
RSV subtype B	0 (0)	1 (4.5)	0.077
Enterovirus	0 (0)	1 (4.5)	0.077

RSV = respiratory syncytial virus. *The following pathogens were not isolated in these samples: influenza B virus, RSV subtype A, adenovirus, parainfluenza virus 2, coronavirus 229E, *Mycoplasma pneumoniae*, *Bordetella parapertussis* and *Fusobacterium necrophorum*. †Calculated using a t-test for continuous variables and a Chi-squared test or Fisher's exact test for proportional values, as appropriate.

students. The upper 95% CI limit of the probability of *F. necrophorum* colonisation occurring in another cohort of the same type was <0.1.

Among the 22 symptomatic patients, 63.6% had Centor scores of ≥ 2 [Figure 1]. Individual score components and total Centor scores for each pathogen are detailed in Table 3. The Centor score was ≥ 2 in 17 symptomatic samples (65.4%; $P < 0.001$). Of these, four samples (23.5%) tested positive for a bacterial pathogen including three (17.6%) with *S.*

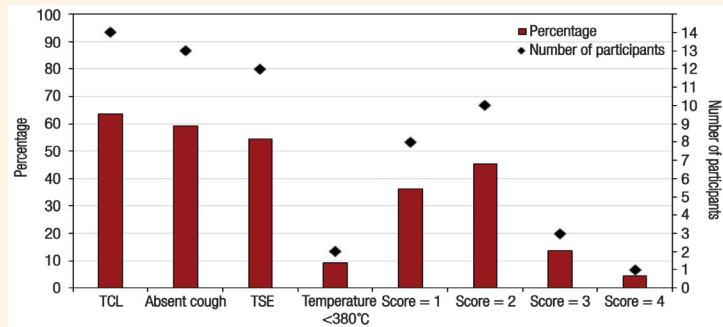


Figure 1: Distribution of symptoms and Centor scores among medical students with symptoms of pharyngitis (N = 22). TCL = Tender cervical lymphadenopathy; TSE = Tonsillar swelling with exsudates.

Table 3: Centor scores and symptoms according to isolated pathogens among medical students with symptoms of pharyngitis (N = 22)

Pathogen	Centor score, n (%)				P value*	Symptom,† n (%)			
	1	2	3	4		Fever	Absence of cough	Swollen, tender anterior CLA	Tonsillar exudates
Rhinovirus (n = 6)	1 (16.7)	4 (66.7)	1 (16.7)	0 (0)	0.564	1 (16.7)	4 (66.7)	3 (50)	4 (66.7)
<i>Streptococcus pneumoniae</i> (n = 3)	0 (0)	2 (66.7)	1 (33.3)	0 (0)	0.305	0 (0)	0 (0)	2 (66.7)	2 (66.7)
<i>Haemophilus influenzae</i> (n = 2)	1 (50)	1 (50)	0 (0)	0 (0)	1.000	0 (0)	0 (0)	2 (100)	1 (50)
Coronavirus NL63 (n = 2)	0 (0)	2 (100)	0 (0)	0 (0)	0.640	0 (0)	1 (50)	1 (50)	2 (100)
RSV subtype B (n = 1)	1 (100)	0 (0)	0 (0)	0 (0)	0.500	0 (0)	1 (100)	0 (0)	0 (0)
Enterovirus (n = 1)	1 (100)	0 (0)	0 (0)	0 (0)	0.500	0 (0)	0 (0)	1 (100)	0 (0)

CLA = cervical lymphadenopathy; RSV = respiratory syncytial virus. *Calculated using a Chi-squared test or Fisher's exact test for proportional values, as appropriate. †Percentages do not add up to 100% as some students had more than one symptom.

Table 4: Incidence of co-infection in the nasopharyngeal swabs of medical students with or without symptoms of pharyngitis (N = 352)

Group	Number of microorganisms isolated, n (%)				
	0	1	2	3	Total
Asymptomatic	281 (86.2)	34 (10.4)	7 (2.1)	4 (1.2)	326 (100)
Symptomatic	15 (57.7)	8 (30.8)	2 (7.7)	1 (3.8)	26 (100)
Total	296 (84.1)	42 (11.9)	9 (2.6)	5 (1.4)	352 (100)

pneumoniae and one (5.9%) with *H. influenzae*. For the remaining samples (76.5%), either no organisms could be identified or the samples were positive for viral isolates only (e.g. rhinovirus or coronavirus). Overall, symptomatic students with Centor scores of ≥ 2 did not have a significantly higher probability of

having a pathogen isolated compared to those with lower scores ($P = 0.892$). Moreover, none of the *S. pyogenes*-positive samples were isolated from students with Centor scores of ≥ 2 ($P = 1.000$).

Overall, 14 samples (4%) were co-infected with one or more different organisms; of these, 11 (78.6%) were asymptomatic and three (21.4%) had pharyngitis. Among the 26 symptomatic samples, eight (30.8%) were positive for a single pathogen, two (7.7%) were positive for two pathogens and one (3.8%) was positive for three pathogens [Table 4]. In the 22 symptomatic students rhinovirus was detected in six students and coronavirus NL63 (RSV B and enterovirus individually isolated in one participant each), while *S. pneumoniae* was identified in three participants and *H. influenzae* was isolated from two samples. Co-infection with both *S. pneumoniae* and rhinovirus occurred in only one asymptomatic student and in two with pharyngitis, although this difference was not statistically significant.

There was no difference in the prevalence of these pathogens according to gender, year of study or stage of study.

Discussion

In the current study, the most commonly isolated microorganisms were rhinovirus, *H. influenzae* and *S. pneumoniae* in medical students both with and without symptoms of pharyngitis. In particular, the prevalence of *S. pneumoniae* was found in 13.6% and 1.5% of symptomatic and asymptomatic students, respectively. The nasopharynx is the main reservoir for *S. pneumoniae*, with particularly high carriage rates in young children which decreases with age.¹⁸ The prevalence of this organism has been linked to smoke exposure, contact with young children in the same household and vaccination status, although these risk factors were not evaluated in the present study.¹⁸ However, the 1.5% prevalence of this pathogen in asymptomatic students raises the issue of antibiotic treatment.

Viral coinfection with RSV or rhinovirus has been associated with a transient 3.8-fold increase in the detection of nasopharyngeal pneumococcal infections in children.¹⁹ In the current study, coinfection with both *S. pneumoniae* and rhinovirus occurred in only one asymptomatic student and in two with pharyngitis. Pneumococcal pharyngitis is rarely reported as being caused by *S. pneumoniae* alone. In fact, only one case report has been published in which an adult patient was found to have a considerable *S. pneumoniae* count and no secondary infections; subsequently, the patient in question was successfully treated with ceftriaxone.²⁰

Moreover, *H. influenzae* was also very unlikely to have been a major cause of pharyngitis in the current study, given the lack of significant difference in its detection rate between symptomatic and asymptomatic participants. In addition, the positivity rates noted in the present study (2.3–9.1%) was less than the 49% reported as a normal component of the human nasopharynx microbiota.²¹ Furthermore, the PCR kit used in the current study was unable to differentiate between typeable (encapsulated) or non-typeable *H. influenzae*, thus making it difficult to confirm the pathogenicity of these isolates. These data support the conclusion that the prescription of antibiotics is unnecessary when this organism is isolated in patients with pharyngitis.

Notably, *S. pyogenes* was completely absent among students with symptoms of pharyngitis. Previous research indicates the prevalence rate of *S. pyogenes*-caused pharyngitis to be approximately 14% using antigen testing in children and 19% using

PCR in children and adults.^{16,22} The PCR results of another study indicated that 10.3% of symptomatic patients and 1.1% of asymptomatic medical students were positive for *S. pyogenes*.¹⁷ Although it is unlikely that the antigen test was more sensitive than the PCR assay for detecting *S. pyogenes* in the present study, it is possible that the collection method of the nasopharyngeal samples might have resulted in a lower bacterial yield than the traditional throat swabs used in the other studies.

A Centor score of ≥ 2 is the suggested cut-off value for the treatment of *S. pyogenes* pharyngitis.² However, this score was assigned to 63.6% of symptomatic students in the current study, none of whom were found to have *S. pyogenes*. This contradicts aforementioned findings regarding the proportion of *S. pyogenes* reported in symptomatic patients (10.3%).²³ While Centor scores of ≥ 2 were not associated with *S. pyogenes* in the present study, they were associated with viruses or other bacteria where penicillin treatment would not be justified. These findings confirm observations from previous reports and suggests that the specificity and sensitivity of this cut-off score for *S. pyogenes* pharyngitis may be much lower in other populations.^{16,24,25} Moreover, this measure may give false-positive results with pathogens other than *S. pyogenes*. Therefore, the authors propose that the Centor cut-off score should not be relied upon to initiate penicillin therapy in the Emirati population, although further studies are necessary to confirm these findings.

In the current study, *F. necrophorum* was not isolated in any of the students, regardless of symptom status. In contrast, previous studies have reported infection rates of this organism to be between 20.5–48% in patients with non-streptococcal tonsillitis and 9.4–21% in controls.^{1,23} Differences between the studied populations might explain this variation in results. Given the use of proper controls in the PCR assays, false-negative results are unlikely to explain the absence of *F. necrophorum* in the present cohort.

The strengths of this study include the fact that it was prospective, with an adequate sample size that included both symptomatic and asymptomatic participants. Unlike previous studies, both an extended virology panel and bacterial pathogen assay were utilised.²⁷ Furthermore, the PCR method used is more sensitive and specific than both a rapid antigen test that focuses exclusively on *S. pyogenes* and also throat cultures where viruses cannot be identified.²² Nonetheless, there were certain limitations. The low overall prevalence of pathogens in the study may be partly attributed to the inclusion of a larger number of asymptomatic as opposed to symptomatic students. An

inadvertent selection bias resulting in under-reporting could also be possible, especially as many students found the nasopharyngeal sampling procedure to be uncomfortable and thus might not have returned if they subsequently developed symptoms of pharyngitis.

Other limitations include the restriction of participants to medical students alone, the absence of bacterial cultures and the lack of information regarding the subsequent clinical progression and treatment of pharyngitis in symptomatic students. Moreover, as the sample was limited to students from a single medical school, the findings of this study cannot be generalised to the rest of the UAE or to other settings. Further studies are needed to address these limitations and should include both adults and children recruited from the general Emirati population.

Conclusion

Colonisation profiles were compared between asymptomatic medical students and those with symptoms of pharyngitis attending a college in the UAE. Among the symptomatic students, a Centor score of ≥ 2 was not associated with *S. pyogenes*, but with viruses and other bacteria instead. Thus, it seems that this score cannot be relied upon as an empirical measure to initiate penicillin therapy in this population. In addition, no cases of *F. necrophorum* were identified, a result which contrasts with those reported elsewhere in the literature. On the basis of these findings, the authors recommend that local guidelines for the management of pharyngitis in young adults in the UAE be reconsidered.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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