Clinical Features of Bacterial Conjunctivitis in Children

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Abstract

Objectives: Conjunctivitis is a common cause of primary care and emergency department (ED) visits. There is a paucity of data in recent literature on the prevalence of pediatric bacterial conjunctivitis, and there are no evidence-based clinical guidelines for empirical treatment. The study objective was to describe clinical features most predictive of bacterial conjunctivitis.

Methods: This was a prospective study in a children's hospital ED. Conjunctival swabs for bacterial culture were obtained from patients aged 1 month to 18 years presenting with red or pink eye and/or the diagnosis of conjunctivitis.

Results: A total of 111 patients were enrolled over one year. Patients had a mean (±SD) age of 33.2 (±37.5) months, and 55% were male. Eighty-seven patients (78%) had positive bacterial cultures. Nontypeable *Haemophilus influenzae* accounted for 82% (71/87), *Streptococcus pneumoniae* for 16% (14/87), and *Staphylococcus aureus* for 2.2% (2/87). Five clinical variables were significantly associated with a positive bacterial culture. Regression analysis revealed that the combination of a history of gluey or sticky eyelids and the physical finding of mucoid or purulent discharge had a posttest probability of 96% (95% confidence interval = 90% to 99%). Subjective scoring by physicians for a positive culture was 50.6%.

Conclusions: Conjunctivitis in children is predominantly bacterial, with nontypeable *H. influenzae* being the most common organism. A history of gluey or sticky eyelids and physical findings of mucoid or purulent discharge are highly predictive of bacterial infection. Based on the above data, empirical ophthalmic antibiotic therapy may be appropriate in children presenting with conjunctivitis.

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Keywords: pink eye, conjunctivitis, eye discharge, bacterial conjunctivitis

Conjunctivitis is a common cause of pediatric primary care visits and is a common ophthalmologic complaint in the pediatric emergency department (ED). Conjunctivitis can be extremely contagious. It is feared that it may be easily spread in day care centers and school classrooms, leading to absences and lost time from work for parents.

The most common causes of conjunctivitis are bacterial and viral infections. In the primary care setting, treatment is based solely on the clinical examination. A 1981 study showed that in the pediatric population, approximately 54% of cases of acute infectious conjunctivitis are caused by a bacterial pathogen.[1] However, physicians prescribe antibiotics nearly 80%–95% of the time.[2,3] Ocular antibiotics, therefore, are considered to be frequently overprescribed, and concerns for increased cost of health care, antibiotic resistance, and adverse reactions are often raised.[3,4] The objective of our study was to describe the point prevalence and clinical features associated with bacterial conjunctivitis in children and to determine if and when empirical topical antimicrobial therapy for conjunctivitis is indicated.

METHODS

Study Design

This was a prospective study conducted in our ED from February 2005 to January 2006. This study was reviewed and approved by our institutional review board. Informed consent was obtained from parents, and informed assent was obtained for children older than 7 years.

Study Setting and Population

We conducted this study in the pediatric ED of a tertiary care suburban children's hospital. All patients aged

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Received June 3, 2006; revision received August 3, 2006; accepted August 3, 2006.

Presented at the 2006 annual meeting of the Pediatric Academic Society, San Francisco, CA, May 2006.

Supported by a Nemours Biomedical Research grant.

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doi: 10.1197/j.aem.2006.08.006
ISSN 1069-6563
PII ISSN 1069-6563583

1 month to 18 years who presented to the pediatric ED with a chief complaint of red or pink eye, eye discharge, or sticky eyelids or eyelashes or who were given a diagnosis of conjunctivitis were eligible for study. Eligible patients were enrolled as a convenience sample.

Patients with a history of eye trauma, recent eye surgery, loss of vision, or symptoms greater than one week in duration were excluded. In addition, patients who wore contact lenses or had been on systemic or local antibiotics within the past week were excluded. Physical examination findings of ciliary redness, ocular foreign body, Kawasaki disease, or Stevens–Johnson syndrome precluded patients' inclusion for study. Enrollment occurred 24 hours a day, seven days a week, for the duration of the study period. However, during times of high ED volume, some patients may have not been enrolled due to lack of physicians' time and availability to enroll subjects in the research study. Patients who were uncooperative with specimen collection were excluded, as were those for whom consent or assent was not provided.

An a priori power analysis was completed for the study using SPSS SamplePower 2.0 (SPSS Inc., Chicago, IL). The null hypothesis was that there would be no relationship between the predictors and the event rate. Under the null hypothesis, the event rate (0.50) was set to be the same at all values for the predictors. Equivalently, the odds ratio (OR) was set to be 1.0, the log OR (β) was set to be 0.0, and the relative risk was set to be 1.0. The criterion for significance (α) for the power analysis was $p = 0.05$, and power level was 0.80. These results showed that a sample of 100 subjects would be sensitive to identify significant predictors with ORs of at least 1.94, β values (log OR) of at least 0.04, and relative risks of at least 1.32. These effect sizes were selected as the smallest effects that would be important to detect.

Study Protocol

For all enrolled patients, a culture of the affected conjunctival sac was obtained. In cases of bilateral eye involvement, the eye with more significant signs or symptoms was used for specimen collection. If both eyes were equally affected, then the first chronologically affected eye was used for the study. Each patient had one conjunctival sample obtained. This process consisted of rolling a thin cotton microswab (Becton Dickinson BBL Culture Swab Liquid Stuart soft aluminium applicator; Becton Dickinson, Sparks, MD) over the lower fornix of the conjunctival sac. The physician staff was instructed on this collection technique, and an illustrative photograph was provided in the collection kit for proper and consistent sample collection (Figure 1).

Figure 1. Sample collection method.

The eye swab was placed into the transport media and sent to the laboratory. The sample from the bacterial transport medium was inoculated into a BAP-TSA II 5% SB (blood agar plate with 5% sheep blood), chocolate agar, Columbia CNA agar with 5% sheep blood, and MacConkey II agar. All media used were prepared plated media from the BD Diagnostic System (Becton Dickinson, Cockesville, MD). After standard inoculation, the MacConkey agar plates were incubated at 35°C for 48 hours in aerobic conditions. The chocolate agar plates, BAP-TSA II 5% SB, and Columbia CNA agar with 5% sheep blood were incubated similarly at 35°C in an aerobic atmosphere supplemented with carbon dioxide. The cultures were analyzed daily for 48 hours according to standard guidelines. The pathogens were identified by using standard biochemical procedures. The suspected colonies were selected and investigated by Gram stain. If the Gram stain was positive, it was followed by a catalase test, then a coagulase or an Optochin test. If the Gram stain was negative, an NHI identification kit was used. Contaminants were defined by our microbiology department and consisted of the following organisms: *Diphtheroid* species, coagulase-negative *Staphylococcus*, *Streptococcus viridians* (α-*Streptococcus*; non-*Pneumococcus*, non-*Enterococcus*), and *Bacillus* species. In addition, cultures that grew a mixture of organisms reflecting normal respiratory flora were also considered as contaminants.

Evaluating physicians were either pediatric emergency physicians or general pediatricians staffing the main ED or the fast track area. Physicians recorded demographic and clinical information on all patients using a standardized data collection form. Historical data collected included presenting complaints, duration of symptoms, and specific features, including the following: type of discharge; sensation of itching, burning, tearing, or foreign body (as perceived by the caregiver in the preverbal child); presence of gluey eyelids or eyelashes or crusty eyes in the morning; history of allergy or fever; and presence of associated symptoms such as sore throat and cough. Physical findings documented included vital signs, presence of conjunctival erythema, lid or periorbital edema, unilateral or bilateral eye involvement, type of discharge, presence of eyelid crusting, amount of discharge, and presence of preauricular nodes.

Additionally, each patient received a subjective probability score for bacterial infection from 0 (most unlikely) to 10 (extremely likely). These scores were assigned by the examining physician upon completion of the data collection sheet. Examining physicians were blinded to the final culture results. Treatment prescribed was also documented.

Data Analysis

Data were entered in a database and analyzed using SPSS 14.0 (SPSS Inc.). Univariate analysis comparing positive and negative culture groups was performed.

Binary stepwise logistic regression was set at 0.05 at entry and 0.1 for removal. For the purpose of this analysis, negative culture and contaminants were grouped and compared with all positive cultures. Dichotomized variables were compared using the chi-square test and Fisher's exact test. Continuous variables were compared with mean and standard deviation using appropriate test according to their parametric distribution. ORs were calculated using the 2 $\times$ 2 contingency tables.

RESULTS

A total of 111 patients were enrolled from February 2005 to January 2006. Patients ranged in age from 2 to 216 months, with a mean ($\pm$SD) age of 33.2 ($\pm$37.5) months, and 55% were male. Seventy percent of the patients had bilateral eye involvement. The positive and negative bacterial culture groups had comparable baseline demographics (Table 1). Eighty-seven patients (78%) had positive cultures. Nontypeable *Haemophilus influenzae* accounted for 82% (71/87) of the positive cultures, with the remainder caused by *Streptococcus pneumoniae* (16% [14/87]) and *Staphylococcus aureus* (2% [2/87]). Contaminants were isolated from 9% (10/111) of the cultures, and the remaining 13% (14/111) had no growth of organisms and were considered negative cultures (Figure 2).

There was no significant difference in the frequency of bacterial isolate based on season of the year. Similarly, there was no association between age, day care attendance, or exposure to others with "pink eye" and positive bacterial culture.

Univariate analysis of historical and clinical features from all enrolled patients was performed, and ORs were calculated (Table 2). A history of gluey or sticky eyelids or eyelashes in the morning (OR, 5.0; 95% confidence interval [CI] = 1.8 to 13.7), examination findings of mucoid or purulent eye discharge (OR, 4.8; 95% CI = 1.8 to 12.6), and eyelids or eyelashes crusting/gluing (OR, 3.0; 95% CI = 1.2 to 7.5) were significantly associated with a positive bacterial culture. Also found to be significant was the lack of sensation of burning eyes (OR, 0.2; 95% CI = 0.1 to 0.8) and the absence of watery discharge (OR, 0.2; 95% CI = 0.1 to 0.7).

Logistic regression using the backward stepwise likelihood ratio method was initially performed on all five features significantly associated with positive bacterial culture. Because of the low frequency of this reported symptom and our mean population age, the potentially less reliable variable of burning sensation was removed and a second analysis was performed. This revealed that the history of gluey or sticky eyelids or eyelashes in the morning (adjusted OR, 3.2; 95% CI = 1.0 to 9.8) and the physical finding of purulent or mucoid discharge (adjusted OR, 4.2; 95% CI = 1.4 to 12.7) were independent variables associated with bacterial conjunctivitis. The combination of these two variables would have a sensitivity of 85% (95% CI = 76% to 91%), a specificity of 73% (95% CI = 40% to 93%), a positive likelihood ratio of 3.1 (95% CI = 1.5 to 8.8), and a posttest probability of 96% (95% CI = 90% to 99%). In our population, antibiotics were prescribed 83% of the time, but subjective scoring by physicians for the high probability for bacterial conjunctivitis (score 6–10) was 50.6% (Figure 3). We did not find significant differences between the clinicians' estimates of patients with and without conjunctivitis when analyzed with comparison of means (p = 0.25). Interestingly, there was no association between otitis media and conjunctivitis in general and specifically in those who had nontypeable *H. influenzae*.

Table 1
Demographics

Characteristics	Bacteria Positive	Bacteria Negative
Age ($\pm$SD), mo	32.4 ($\pm$38.7)	36.0 ($\pm$33.3)
Gender, % male	56	50
Duration of symptoms ($\pm$SD), days	1.27 ($\pm$0.55)	1.2 ($\pm$0.50)
Percent attending day care	48	50
Percent with temperature >38.0°C	20	25
Actual temperature in ED ($\pm$SD), °C	37.3 ($\pm$1.2)	37.2 ($\pm$1.0)

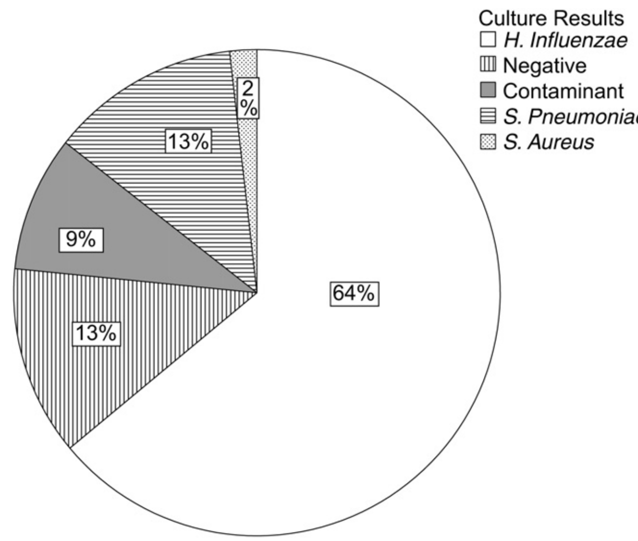

Figure 2. Culture results.

DISCUSSION

Conjunctivitis is a common pediatric diagnosis made in both the primary care and ED settings. Its prevalence is significant to the general population, because it is a leading cause of day care and school absences. Even though most cases of bacterial conjunctivitis are self-limited, it can take up to three weeks for the infection to clear. Treatment of acute conjunctivitis helps to shorten the clinical course, reduces spread of the contagion and discomfort, and allows the patient to resume activities earlier.[5] The etiology is difficult to delineate on clinical grounds alone, and there is much pressure on physicians to prescribe antibiotics due to the social impact the diagnosis holds. Thus, physicians are faced with the dilemma of potentially overprescribing antibiotics in an era of increasing bacterial resistance and increased awareness of cost.

Pediatric and emergency medicine literature lacks clinical diagnostic indicators to assist practitioners in making a more informative decision about the need for ocular antibiotics because results from a culture of the conjunctiva may be delayed by several days.[3] Most cases of acute

Table 2
Univariate Analyses of Clinical Features

Finding	Percent Frequency of Reported Symptoms in Culture-positive Patients	p-value	OR (95% CI)
Historical			
Eye discharge	84	0.5	0.8 (0.2, 2.8)
Fever	41	0.08	0.4 (0.2, 1.1)
Rhinorrhea	79	0.6	1.0 (0.3, 2.8)
Cough	58	0.3	0.8 (0.3, 2.3)
Sore throat	10	0.5	0.7 (0.2, 2.8)
Itching/rubbing	63	0.4	1.2 (0.50, 3.1)
Burning	6	0.031*	0.2 (0.1, 0.8)
Tearing	54	0.2	0.6 (0.3, 1.6)
Environmental allergy	5	0.1	0.3 (0.1, 1.3)
Previous conjunctivitis	11	0.5	0.7 (0.2, 2.7)
Foreign body sensation	2	0.8	0.5 (0.1, 6.8)
Gluey/sticky eyes in morning	86	0.003*	5.0 (1.8, 13.7)
Day-care exposure	51	0.4	0.8 (0.3, 2.1)
Exposure to conjunctivitis	20	0.3	2.0 (0.5, 8.6)
Clinical			
Temperature >38.0°C	25	0.3	1.5 (0.5, 4.2)
Conjunctival injection	99	0.4	3.7 (0.3, 37.0)
Mucoid or purulent discharge	85	0.003*	4.8 (1.8, 12.6)
Watery discharge	11	0.011*	0.2 (0.1, 0.7)
Eyelid crusting/gluing	68	0.017*	3.0 (1.2, 7.5)
Preauricular node	1	0.4	0.3 (0.3, 2.8)
Rhinorrhea	73	0.4	0.7 (0.3, 2.0)
Cough	58	0.3	0.7 (0.3, 2.8)
Otitis media	29	0.4	1.3 (0.5, 3.4)
Eyelid erythema	42	0.1	2.1 (0.8, 5.6)
Rash	10	0.2	0.5 (0.2, 1.7)
Pharyngitis	11	0.6	1.2 (0.3, 5.4)
Eyelid edema	23	0.3	0.5 (0.2, 1.2)
Presence of discharge	95	0.2	2.9 (0.7, 12.6)

* $p < 0.05$.

infectious conjunctivitis are self-limited, and 64% resolve in two to five days.[6,7] Untreated, acute bacterial conjunctivitis is clinically cured within three to five days in 28% of cases, and by eight to ten days there is a 72% clinical cure rate. There is bacteriologic cure of 19% and 31% of the same untreated groups. If treated with antibiotics, these numbers improve to 62% clinical cure at three to five days and 91% at eight to ten days, with bacteriologic cure of 71% and 79%, respectively.[8] Recent studies have shown that topical antibiotics impact microbiologic remission by six to ten days.[9] Thus, there is support for treating bacterial conjunctivitis because it leads to more rapid and improved rates of clinical remission.[6,7,10]

The Red Book and the National Health and Safety Performance Standards guidelines suggest that children with conjunctivitis without systemic illness should be allowed to remain in school once indicated therapy is implemented.[11,12] This is especially important for parents whose children attend day care and school, because treatment may not only hasten symptomatic resolution but also shortens absences, allowing parents to return to work more quickly. Early recognition and treatment may also be important in decreasing transmission of infective pathogens.

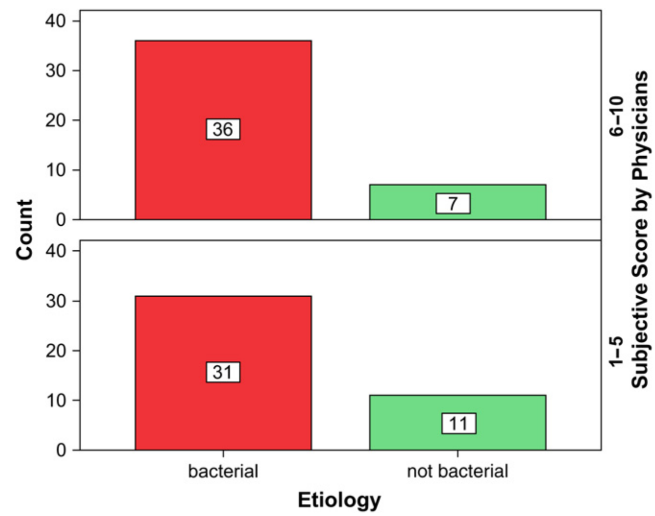

Figure 3. **Physicians' subjective probability scores for positive bacterial cultures.**

Practitioners rely on certain signs and symptoms listed in the literature and major textbooks that will distinguish a bacterial from a viral origin of conjunctivitis.[13–16] Purulence, swollen eyelid, and a papillary response are generally associated with bacterial etiologies, while watery discharge, a follicular response, and a preauricular node are more indicative of a viral picture. However, these signs and symptoms are associative findings and are nonspecific.[15] A recent literature review by Rietveld et al. found no evidence for these commonly used predictors.[13] Rietveld et al. additionally showed that acute bacterial conjunctivitis in the adult population is predicted by a positive history of early morning glued eyes and a lack of history of itch and previous episodes of conjunctivitis.[3]

Our data, as in prior studies, showed an even higher predominance of bacteria identified in cases of conjunctivitis (78% culture positive). Our leading isolated organism was nontypeable *H. influenzae*, followed by *S. pneumoniae*. These data support results from prior studies and also indicate some change in the types and frequency of isolates.[1,4,17–20] Additionally, we isolated *S. aureus* in 2% of culture-positive cases. Although prior studies have listed this organism as either a contaminant or normal flora,[1,4,20] we believe that this could be a true pathogen. We argue that our means of sample collection enhanced our ability to isolate appropriate organisms by using a thin cotton microswab and providing our physicians with ample education about sample collection. These techniques minimized sampling errors and risks for contamination.

We have also shown that physicians underestimate the prevalence of bacteria as an etiology of conjunctivitis.

Yet, despite our physicians' estimates, antibiotics were prescribed 83% of the time and were correctly prescribed 86% of the time. Although not quantified in this study, we believe that this high rate of treatment was triggered by parental concerns regarding day care and/or school absences. Other studies have also shown this high rate of antibiotic treatment.[2,3]

In this study, five independent variables were significantly associated with positive bacterial cultures. These included a history of gluey or sticky eyelids or eyelashes in the morning, examination findings of mucoid or purulent eye discharge, and examination findings of eyelids or eyelashes crusting or gluing. Also found to be statistically significant was the lack of sensation of burning eyes and the absence of watery discharge. Even though lack of burning is significantly associated with bacterial conjunctivitis, our data may represent information bias from the caregivers' perception of this symptom. Because many enrolled children in this study were younger than 5 years, clinicians are cautioned to use their best clinical judgment with regard to the reliability of this finding. The presence of these later findings could be suggestive of allergic or viral etiology.

Binary logistic regression identified a history of gluey or sticky eyelids or eyelashes in the morning and the presence of mucoid or purulent discharge on examination as independent variables. When combined as a clinical predication tool, it yielded high diagnostic characteristics (posttest probability of 96%). We believe that physicians may use these historical and examination findings to better delineate their treatment strategies.

LIMITATIONS

One of the limitations of this study is that enrollees were not consecutively entered. Although we did not present data on those who were not enrolled, we believe that patients were selected without bias, given our physicians' subjective scoring results. Another limitation of this study is that patients were enrolled in a single suburban tertiary care hospital, and the results may not be applicable to other patient populations.

CONCLUSIONS

There are a large number of cases of pediatric conjunctivitis that are bacterial in origin, with *H. influenzae* as the overwhelmingly predominant organism. Based on the above data, empirical ophthalmic antibiotic therapy for children presenting with conjunctivitis may be appropriate if used with guidance of the diagnostic indicators identified in our study.

The authors thank Lizabeth Marek and the microbiology department for their help with the bacterial cultures and the emergency physicians at the Alfred I. duPont Hospital for Children for their help with patient enrollment.

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