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SHORT REPORT
E-mail surveys assist investigation and response: a university conjunctivitis outbreak

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SUMMARY

A conjunctivitis outbreak affecting more than 200 individuals occurred on a university campus in Evanston, Illinois, USA, in spring 2002. An investigation was conducted jointly by the Evanston Department of Health and the Illinois Department of Public Health. A combination of e-mail and traditional telephone-based surveys demonstrated that wearing contact lenses was a risk factor for any conjunctivitis and bilateral conjunctivitis, whereas using glasses was protective. Laboratory and epidemiological evidence suggested that the outbreak was caused by a viral pathogen that eluded characterization despite extensive culture and PCR-based laboratory testing. Enhanced laboratory surveillance could help clinicians and public-health officials to identify relevant secular changes in the spectrum of causes of conjunctivitis. During institutional outbreaks, e-mail surveys can help public-health officials to efficiently access information not easily collected by traditional case-control studies, and can provide an effective conduit for providing prevention recommendation, such as the need for improved hand and contact-lens hygiene during outbreaks.

In April 2002, the Evanston City Department of Health contacted the Illinois Department of Public Health (IDPH) to request assistance in investigating an outbreak of conjunctivitis at a local university with nearly 9000 students; 4150 (61%) out of 6750 full-time undergraduates lived on campus. Visits to the university's student health clinic (the clinic) for evaluation of conjunctivitis had increased since students had begun spring term classes on 2 April 2002.

To verify the existence and size of the outbreak, we compared the number of clinic visits for conjunctivitis in March and April 2002 with computerized clinic data for those months in the preceding three years (1999–2001) and sent an e-mail survey (see Table) to all current students. The survey requested information about eye symptoms, demographic characteristics, and eyewear or contact-lens use. We contacted local ophthalmologists' offices and hospital emergency departments to ascertain whether the outbreak had spread to the surrounding community.

To characterize the conjunctivitis, we abstracted retrospectively signs and symptoms from medical records of all students diagnosed with conjunctivitis at the clinic since 1 March 2002 (patients) and developed a prospective, enhanced symptom questionnaire for clinic practitioners. To define risk factors for conjunctivitis, we conducted a telephone-administered case-control study. Cases were students who presented to the clinic and received an ICD-9 code diagnosis of conjunctivitis (but not allergic conjunctivitis) from 1 March to 12 May 2002, inclusive.

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Table. *E-mail questionnaire used to help evaluate the scope of the conjunctivitis outbreak and to locate potential respondents for the telephone-administered case-control study* (*square brackets represent space for an electronic response*)

- Where were you living in April 2002 (check one)?
  [ ] Dormitory _____ [Dormitory list provided]
  [ ] Off campus (private) housing
- Were you a patient at the Northwestern Health Service since 22 March 2002 (the last day of the winter examination period)? [Yes/No]
- Did you travel outside the continental U.S. during spring break? [Yes/No]
- Between 15 March 2002, and now, have you been diagnosed with conjunctivitis or pinkeye by a doctor or nurse? [Y/N]
- Between 15 March 2002, and now, which of the following problems have you noticed:
  - Red or Painful eye(s) [Y/N]
  - If yes, did the problem occur in one or both eyes [One/Both]
  - Fever (either measured by thermometer or simply feeling feverish) [Y/N]
  - Unusual fatigue, 'flu-like' symptoms [Y/N]
- How many persons have you seen in the past week who you thought looked like they might have conjunctivitis (pinkeye) [_____]
- Did you wear contact lenses at any time since 22 March 2002? [Y/N]
- Are you male or female (check one)? [Male/Female]
- May we contact you to offer you a confidential interview by phone in the next week? This interview will help us with our public health investigation (names and e-mail address will be kept confidential) [Y/N]
  - If yes, what is the best telephone number for us to contact you? [_____]
  - If yes, what is the best time to call you? [_____]

Controls were students who presented to the clinic and who received an ICD-9 code diagnosis of upper respiratory tract infection (URTI) (but not conjunctivitis) from 1 March to 12 May 2002 inclusive. The study period was the 10-day period before onset of illness.

To minimize the nosocomial transmission of conjunctivitis, we asked the clinic to institute a control programme that included cohorting patients and granting leave of absence to staff with suspected conjunctivitis, reinforcing frequent handwashing and surface disinfection and eliminating multi-dose vial use for all ophthalmic medications [1, 2]. To minimize the spread of conjunctivitis outside the clinic, we prepared web- and print-based fact sheets for the university and local community.

To determine the aetiology of the outbreak, conjunctival and throat swabs obtained by physicians or trained registered nurses were streaked onto blood agar and incubated for 96 h at the university's microbiology laboratory; culturing on chocolate agar (for enhanced detection of *Haemophilus* spp.) was not performed. Conjunctivitis samples and throat swabs also were placed in viral transport media and cultured in human foreskin, MRC5 lung fibroblast, A549 lung carcinoma, canine kidney, and monkey kidney cell lines at IDPH and Wisconsin State Health Department Laboratories. Specimens were sent to the Respiratory Virus branch, the Enterovirus Section, and the Mycoplasma Section of the Centers for Disease Control and Prevention (CDC) for evaluation by polymerase chain reaction (PCR) for adenovirus, enterovirus, influenza virus A, *Mycoplasma pneumoniae*, *Chlamydia psittaci*, and *C. pneumoniae*. Specifically, adenovirus presence was assessed by a multiplex PCR [3], while enterovirus presence was assessed by conventional PCR [4] at the California Department of Health Services Viral and Rickettsial Diseases Laboratory (CDHS), and by 5′-NTR semi-nested PCR at CDC.

Clinic records showed 21 and 96 student visits for conjunctivitis in March and April 2002 respectively, compared with a median of 18 and 40 visits in the same months over the preceding three years. Telephone calls to local ophthalmologists' offices and emergency departments that were placed between 30 April and 3 May 2002 inclusive, revealed no increases in visits for conjunctivitis at these locations. The clinic reported 106 cases in May 2002; the outbreak terminated at the end of May, when most students left the campus. During those 3 months, 232 students were diagnosed with conjunctivitis by the student health clinic.

Of 77 conjunctivitis patients who presented to the clinic in March and April 2002, 53 (69%) reported a concurrent URTI. Symptoms common to these

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URTIs included coryza ($n=30$), sore throat ($n=27$), and cough ($n=18$). All patients had injected conjunctivae by complaint or by physical examination; both eyes were affected in 55 (56%) out of 99 cases. Associated findings included crusting of the eyes or purulent, sticky discharge ($n=58$), serous discharge ($n=36$), pain or foreign body sensation ($n=25$), photophobia ($n=11$), and palpebral or periorbital swelling ($n=8$). No patient had a documented temperature above 38·4 °C. No patient reported vomiting or diarrhoea, and there was no subjective or objective neurological dysfunction noted. Of patients who provided the relevant information, 41 (57%) out of 72 wore contact lenses, 35 (49%) out of 72 wore glasses and 2 (10%) out of 23 wore an eyebrow ring.

The 10-item e-mail survey was sent to 8950 students on 12 May 2002 and returned by 1027 students (11%) within 10 days. Of these, 185 (18%) reported pink eye since 1 March 2002. Of the students reporting pink eye, 60 (32%) had been diagnosed with conjunctivitis by a physician. Respondents who developed pink eye were equally likely to live on campus [134 (73%) out of 184 *vs.* 614 (74%) out of 834; odds ratio (OR) 1·0, 95% confidence interval (CI) 0·7–1·4], or to be male [87 (47%) out of 185 *vs.* 367 (43%) out of 845; OR 1·2, 95% CI 0·8–1·6], but were more likely to wear contact lenses [93 (51%) out of 183 *vs.* 353 (42%) out of 844; OR 1·4, 95% CI 1·0–2·0] than students who were unaffected. Persons who wore contact lenses were more likely to be infected in both eyes [61 (66%) out of 93 of persons who wore contact lenses *vs.* 45 (50%) out of 90 who did not; OR 1·9, 95% CI 1·0–3·6].

The 35 cases who participated in the telephone-administered case-control study were younger than the 31 controls (median age 20 *vs.* 22 years; $P=0·02$), but there was no difference in the frequency of on-campus residence [25 (74%) out of 34 cases *vs.* 15 (71%) out of 21 controls; OR 1·1, 95% CI 0·3–4·2] or in gender distribution [18 (51%) *vs.* 12 (39%) male; OR 1·7, 95% CI 0·6–5·0]. Smoking, or having a room-mate who smoked, was not associated with illness. Cases and controls were also equally likely to have worn contact lenses during the study period [15 (42%) out of 35 *vs.* 13 (43%) out of 31; OR 1·0, 95% CI 0·3–2·9]. However, cases were less likely to have worn glasses during the study period [4 (12%) out of 34 *vs.* 14 (45%) out of 31; OR 0·2, 95% CI 0·03–0·6]. This association remained after adjustment for the wearing of contact lenses (adjusted OR 0·1, 95% CI 0·03–0·6). No single activity, major course of study, or eating hall was associated with conjunctivitis and there was no difference in the daily use of public computers (mean 1·1 h among cases *vs.* 1·2 h among controls, $P=0·9$); all cases and all but two controls owned their own computer.

Conjunctival bacterial cultures from 15 students (17 eyes) demonstrated normal flora without a dominant bacterial pathogen. Four conjunctival (and four pharyngeal) samples collected in mid-April showed a cytopathic effect in canine kidney cell culture. Testing by the Wisconsin State Laboratory and CDHS did not confirm the presence of a specific virus. Sets of specimens (conjunctival and throat swab) from four patients diagnosed with conjunctivitis in May 2002 and sent directly to CDHS were tested for enterovirus by culture and PCR; rhinovirus was found in two throat specimens but zero conjunctival specimens. Sets of specimens from three patients diagnosed with conjunctivitis in May 2002 sent directly to CDC revealed no enterovirus or adenovirus nucleic acid by PCR; further PCR testing of these specimens revealed no *M. pneumoniae*, *C. psittaci*, or *C. pneumoniae* nucleic acid.

This outbreak led at least 232 students to seek treatment for conjunctivitis from their University Student Health Service from March to May 2002. Anecdotal evidence and an e-mail survey suggested that the outbreak was considerably larger. Although the outbreak aetiology remained elusive, we suspect that it was caused by an uncultivated viral agent. Evidence for this includes the positive viral cytopathic effect found on initial testing of four early samples and the high frequency of upper respiratory symptoms with coryza among conjunctivitis victims [5]. The difficulty in isolating a specific virus may have been due to suboptimal specimen collection or processing, but the possibility that this outbreak – and future outbreaks – could be caused by unusual or newly recognized viral pathogens cannot be dismissed. The most common and several rare causes of epidemic conjunctivitis [6–8] were excluded by regional and national reference laboratories. Because conjunctivitis is frequently benign, culture is rarely performed. As a result, clinicians and public-health officials may overlook secular changes in the spectrum of conjunctivitis aetiologies.

In the case-control study, wearing glasses was associated with a decreased risk of conjunctivitis. Explanations for this finding include the possibilities that glasses provide a barrier against droplet transmission of viruses or that persons wearing glasses

touch their eyes less frequently than those who do not. Since this effect was independent of contact-lens use, it seems prudent to suggest that contact-lens wearers should switch to glasses, if feasible, during conjunctivitis outbreaks.

In the e-mail survey, wearing contact lenses was associated with conjunctivitis and with bilateral disease. During institutional outbreaks, e-mail surveys can help to efficiently access information that is not easily collected by traditional case-control studies. E-mail surveys also provide a simple, easy conduit for disseminating prevention recommendations such as the need for improved hand and contact-lens hygiene during outbreaks [9].

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