

MANAGEMENT OF ENTEROVIRAL CONJUNCTIVITIS OUTBREAKS IN THE SINGAPORE MILITARY IN 2005

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Abstract. Between 8 August and 9 October 2005, tropical Singapore experienced a national epidemic of acute viral conjunctivitis. We report the epidemiological and virological findings of outbreaks of viral conjunctivitis in military facilities during the same time period, and the outbreak control measures taken. Outbreaks of viral conjunctivitis were identified by medical officers in military medical facilities. Epidemiological and virological investigations were carried out, and a standard set of control measures was instituted for each outbreak upon detection. Eight outbreaks of viral conjunctivitis occurred in the time period, corresponding to the national outbreak. Delayed detection and institution of preventive measures during the outbreaks were associated with delayed effectiveness of the control measures. Every delay in outbreak detection by one day resulted in a delay in terminating the outbreak by 0.82 days ($p=0.01$). Coxsackievirus A24 was identified from some of the conjunctival swab samples taken.

INTRODUCTION

Acute viral conjunctivitis is a self-limiting infection with substantial morbidity, requiring up to 3 weeks to resolve (Morrow and Abbott 1998), and remaining highly contagious for up to several weeks after the onset of symptoms. Epidemic viral conjunctivitis is generally attributed to adenoviruses (which cause epidemic keratoconjunctivitis and pharyngoconjunctival fever) and enteroviruses, including enterovirus type 70 and coxsackievirus A type 24 variant (which induce acute hemorrhagic conjunctivitis) (Chang *et al*, 2003). Outbreaks of viral conjunctivitis can cause widespread morbidity; for example approximately one million people in Japan annually infected (Infectious Agents Surveillance Center of Japan, 1995). Conjunctivitis has thus gained recognition as a major public health issue resulting in mor-

bidity and work loss. However, there are few studies describing the impact of viral conjunctivitis outbreaks in tropical regions or in close-quarters military settings.

In tropical Singapore, the annual incidence rate of viral conjunctivitis is about 7 per 1,000 (in 2004, 31,261 among 4.3 million individuals in Singapore were infected) (Ministry of Health, Singapore, 2005). Epidemics of acute viral conjunctivitis have occurred in about 5 to 10 year cycles since the 1970s (Ministry of Health, Singapore, 2005). The 1970, 1975 and 1985 epidemics were caused by coxsackievirus A24 and the 1980 epidemic by enterovirus 70. Coxsackievirus A24 continued to cause epidemics in 1987, 1992 and 2002, while most of the viruses isolated during small outbreaks in the inter-epidemic period were adenovirus subtypes (Ministry of Health, Singapore, 2005).

From 8 August to 9 October 2005, Singapore experienced another national epidemic of acute conjunctivitis, with the weekly incidence of infection rising from a baseline of

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500-700 cases per week, to a peak of 2,171 in the week ending 27 August 2005 (Ministry of Health, Singapore, 2005). The Singapore Armed Forces (SAF), being a conscript military with personnel and facilities in close proximity to the general population, also experienced a concurrent increase in the number and size of viral conjunctivitis cases within military facilities.

The aim of this study is to report the epidemiological and virological findings of outbreaks of conjunctivitis in tropical military facilities in Singapore between 8 August and 9 October 2005; and to describe the public health measures that were instituted to curtail the spread of infection.

MATERIALS AND METHODS

The SAF Medical Corp provides primary healthcare to all personnel in SAF facilities through medical centers. Personnel with conjunctivitis who presented at these medical centers were identified by medical officers based on clinical signs and symptoms, such as eye discomfort and the presence of conjunctival injection. Cases with atypical features, such as severe pain or blurring of vision, were referred for specialist consultation to exclude other pathologies such as corneal ulcers or angle closure glaucoma, before a diagnosis of conjunctivitis was confirmed.

An outbreak of conjunctivitis within the SAF was defined as two or more cases of conjunctivitis occurring in the same company (military unit) or office with symptom onset within a single 24 hour period. This includes cases that presented to the medical center or those that sought treatment elsewhere and reported the diagnosis to the medical officer. Medical officers in the SAF medical centers were therefore responsible for the identification of conjunctivitis outbreaks among personnel under the purview of their medical facility. Upon identification of an outbreak, medical officers would in-

form medical headquarters of the outbreak via telephone and e-mail within 24 hours, and provide information on disease onset, symptoms, location, and other pertinent information for each patient. The medical officer would also initiate a standard set of immediate control measures, such as case isolation, personnel and facility inspection, and provision of basic hygiene and public health advice to the affected unit or office personnel.

In addition, an epidemiology team from medical headquarters would be dispatched to confirm the presence of a conjunctivitis outbreak, and to advise on the need for additional control measures to further reduce spread, if necessary. Outbreaks were monitored by active surveillance and case identification, and included tracking the number of new cases from the affected unit daily. Outbreaks were considered over when 6 days (two incubation periods) had elapsed from the time of isolation of the last case.

Ethical approval was obtained for the study from the institutional ethics board.

Statistical analysis with regression models was used to correlate between the day of onset of the 1st case to detection of the outbreak with the duration from intervention to the onset of the last case in the cluster. This was to prove the hypothesis that delays in detection of the outbreak and the institution of preventive measures resulted in delays in terminating the outbreak.

Conjunctival swabs were taken from some patients for viral detection and identification via polymerase chain reaction (PCR) assays and tissue culture. All specimens were sent to the Defence Medical and Environmental Research Institute (Defence Science Organisation, Singapore) for testing.

RESULTS

Epidemiologic results

Eight outbreaks of viral conjunctivitis

Table 1
Epidemiologic features of outbreaks of viral conjunctivitis in the SAF.

Outbreak	Index onset date	Total number of cases	Maximum cases/day	Days from 1 st case onset to recognition of outbreak	Days to peak incidence	Days from intervention to last case	Duration of outbreak (days)	Remarks
A	13-Aug	51	7	11	11	10	22	Initial cases escaped notice because they received outside treatment
B	19-Aug	32	7	4	4	8	9	Index case delayed in reporting being sick
C	10-Sep	7	2	2	2	1	4	
D	21-Sep	8	4	2	2	1	2	Outbreak peaked on the last day
E	4-Oct	5	2	1	0	2	3	Outbreak peaked on first day
F	4-Oct	19	7	2	2	4	6	
G	5-Oct	12	5	1	0	3	4	Outbreak peaked on first day
H	9-Oct	8	2	2	2	5	8	

involving a total of 142 personnel occurred from 8 August to 9 October 2005. The epidemiologic features of these outbreaks are summarized in Table 1. The total number of cases in each outbreak ranged from 5 to 51, and the duration of the outbreaks (defined as the number of days from the onset of symptoms in the index case to the onset of symptoms in the last case) ranged from 2 to 22 days. The mean time from onset of ocular symptoms to presentation to the SAF medical facilities was 1.44 days (range 0 to 12 days).

Seven of the 8 outbreaks peaked between 1 to 4 days after the onset of the index case, with most peaking in the first half of the period of the outbreak. The remaining outbreak (outbreak A), peaked 11 days after onset of the index case; and had the longest total duration of 22 days, which was more than twice that of the next longest outbreak (outbreak B, for 9 days). Outbreaks A and B were the largest and most prolonged of the outbreaks. In outbreak A (Fig 1), the initial 7 cases escaped notice because they obtained treatment and medical leave from external private clinics, which were out of the military's purview, and did not report their diagnosis until their return from medical leave. The medical officer-in-charge was therefore unaware of the evolving outbreak until a total of 14 cases had occurred. In the case of outbreak B (Fig 2), the initial cases had waited 4 days before presenting to the medical facility, resulting in a substantial number of secondary cases before the outbreak could be recognized and control measures instituted.

Standard outbreak control measures that were implemented across the outbreaks included isolation of all cases as soon as identified, daily screening of all contacts for new conjunctivitis cases, inspection of living quarters for possible facilitating factors, such as overcrowding, increasing the ventilation within the living quarters, and thorough cleaning of equipment and surfaces used by infected

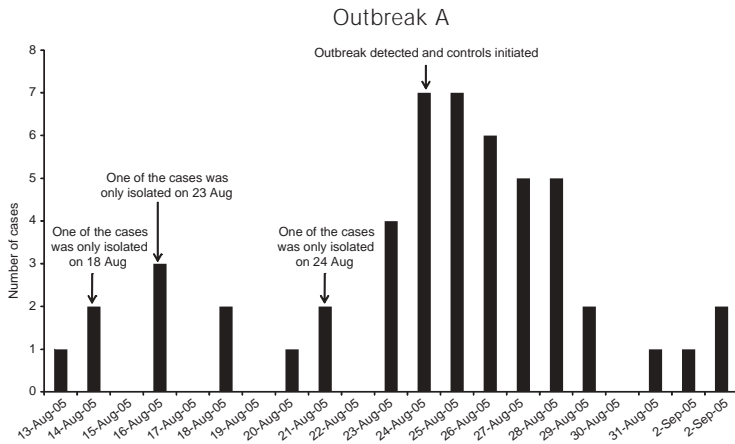


Fig 1-Epidemic curve for outbreak A.

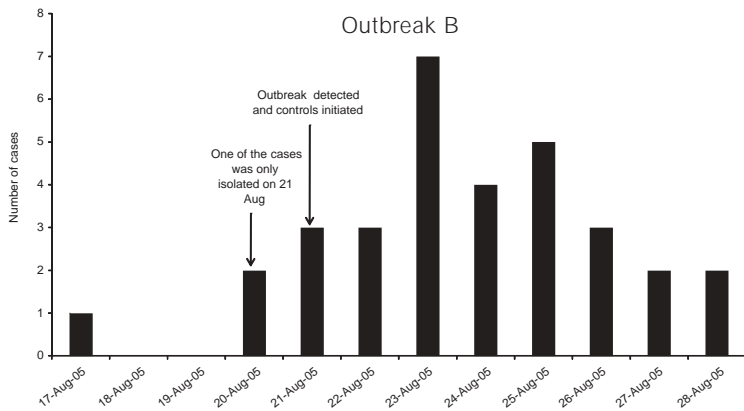


Fig 2-Epidemic curve for outbreak B

personnel. Strict instructions were given to all personnel not to share personal effects, such as towels, which might act as fomites for disease transmission, and to pay closer attention to personal hygiene measures such as hand washing.

The mean time from institution of control measures to the termination of an outbreak was 4.25 days (range 1-10 days). Smaller outbreaks ended more quickly than larger outbreaks after the institution of control measures. From regression analysis, every one day delay in detection of the outbreak resulted in a delay in the success of the preventive mea-

asures in terminating the outbreak by 0.82 days ($p=0.01$). None of the military units were repeatedly affected by conjunctivitis outbreaks in succession.

Virological results

A total of 53 conjunctival swab samples were taken from the outbreaks; 23 were taken from outbreak A, 19 from C and 12 from F and G. Two of the samples from A were positive for enterovirus on PCR. Subtyping showed that one of the two samples was likely coxsackievirus A24 (CA24), while no definitive organism could be isolated from the remaining samples.

DISCUSSION

Our findings are in line with national virological findings at that time in which CA24 was also isolated from conjunctival swabs taken from polyclinics and nursing homes (Ministry of Health, Singapore, 2006). The isolation of CA24 from cases within the SAF and in the local community suggests that index cases of viral conjunctivitis within the SAF may have acquired infection from outbreaks in the general community. This is likely because of the frequent interactions between SAF personnel and the general community. There has been evidence to suggest that epidemics of conjunctivitis caused by specific viruses may occur when herd immunity falls below a critical level (Goh *et al*, 1990); this may explain the cyclical occurrences of conjunctivitis epidemics in Singapore.

Outbreaks of conjunctivitis caused by

enterovirus are characterized by a short incubation period, and high secondary attack rates (Hierholzer and Hatch, 1985). The typical incubation period ranges from 12 hours to 3 days. The short incubation period may contribute to the rapid spread of disease, producing the explosive outbreaks observed, and consistent with other reported outbreaks caused by CA24 in tropical regions (Yin-Murphy *et al*, 1976; Satpathy *et al*, 1996; Moura *et al*, 2006). The continuation of outbreak control measures for 6 days after the date of isolation of the last case was therefore sufficient in this case to prevent recurrence in tropical climates. However, future measures should take into account the viral type due to differences in the incubation periods.

Conjunctivitis outbreaks are a common problem in the military setting due to relatively crowded living conditions, and the difficulty in maintaining ideal hygiene during busy training periods. Our experience suggests that infection control interventions, such as active case surveillance and isolation, education to improve personal hygiene, and measures to improve ventilation and relieve overcrowding, may be effective in reducing disease spread during outbreaks of conjunctivitis. This was shown by the sharp decrease in case incidence after the institution of outbreak control measures as seen in outbreaks A and B. In addition, outbreaks in which intervention was delayed were larger in numbers and resulted in a delay in the time until termination of the outbreak. This suggests that later intervention may result in greater spread of the disease and therefore greater difficulty in terminating the outbreak. However, the decrease in case incidence may have also been due to the outbreak being on the downward trend of the epidemic curve during the institution of interventions. Even though this is unlikely given the large number of young, susceptible conscript personnel within each camp (in the thousands), causal association between interven-

tion and a decline in incidence cannot be proven from the current data, and should form the basis for further studies.

In addition to infection control measures, the protocols for immediate reporting through telephone and e-mails in the SAF allowed for rapid communication and near real-time sharing of data. This facilitates the central management of multiple outbreaks of conjunctivitis, including instituting additional preventive measures and promulgating advisories to unaffected units. The close linkage between the central medical body responsible for supervision of outbreak management and the ground entities responsible for execution of outbreak management actions allows for coordinated outbreak investigation and management response. Other studies have also corroborated the utility of e-mail communication during infectious disease outbreaks (Pryor *et al*, 2002).

Additional surveillance mechanisms should be created to enable earlier case detection and prevent delays in detection and reporting of cases. In outbreak A, outside treatment was not noted until a later date; in outbreak B, the patient delayed reporting his symptoms. Active mechanisms to enable early identification, such as active screening and active review of the diagnosis from external private medical consults, may have picked up the cases earlier, and prevented the outbreaks from becoming substantial.

There were some limitations to the study. No case-controls were carried out for the outbreaks due to lack of data, making it difficult to comment on the possible sources of exposure for the cases. However, a case-control study would have been unlikely to reveal specific exposure factors, since the close living conditions and regimented activities meant that most members of any given unit would have had similar exposures. Similarly, this study could not address the effectiveness of control measures because of the need to provide advice in an attempt to reduce the spread

of infection. It was also not possible to be certain that CA24 was responsible for all the cases since the virus was not isolated in all patients. However, in the setting of a national epidemic of conjunctivitis due to CA24, it is likely the majority of the clusters were caused by that virus. Adenovirus, which is also a common cause of epidemic conjunctivitis, was not detected in any of the patient samples.

In conclusion, conjunctivitis outbreaks can lead to substantial loss of productivity due to the highly contagious nature of the disease, and prolonged recovery period. Our experience suggests that early intervention in an outbreak, with an emphasis on surveillance, early detection, personal hygiene, and active detection of cases may help limit the extent of an outbreak and reduce the impact of the disease in terms of working days lost to illness.

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REFERENCES

- Chang CH, Lin KH, Sheu MM, Huang WL, Wang HZ, Chen CW. The change of etiological agents and clinical signs of epidemic viral conjunctivitis over an 18-year period in southern Taiwan. *Graefes Arch Clin Exp Ophthalmol* 2003; 241: 554-60.
- Goh KT, Ooi PL, Miyamura K, Ogino T, Yamazaki S. Acute haemorrhagic conjunctivitis: seroepidemiology of coxsackievirus A24 variant and enterovirus 70 in Singapore. *J Med Virol* 1990; 31: 245-7.
- Hierholzer JC, Hatch MH. Acute hemorrhagic conjunctivitis. In: Darrell RW, ed. *Viral disease of the eye*. Philadelphia: Lea & Febiger, 1985: 165-96.
- Infectious Agents Surveillance Center of Japan. Viruses isolated from the eye, Japan, 1990-1994. *Infect Agents Surveill Rep* 1995; 16: 97-8.
- Ministry of Health, Singapore. Communicable disease surveillance in Singapore 2004. Singapore, 2005.
- Ministry of Health, Singapore. Communicable disease surveillance in Singapore 2005. Singapore, 2006.
- Morrow GL, Abbott RL. Conjunctivitis. *Am Fam Physician* 1998 15; 57: 735-46.
- Moura FE, Ribeiro DC, Gurgel N, *et al*. Acute haemorrhagic conjunctivitis outbreak in the city of Fortaleza, northeast Brazil. *Br J Ophthalmol* 2006; 90: 1091-3.
- Pryor JH, Martin MT, Cynthia G, *et al*. Rapid response to a conjunctivitis outbreak: The use of technology to leverage information. *J Am Coll Health* 2002; 50: 267-71.
- Satpathy G, Mohanty S, Nayak N. An epidemic of viral acute haemorrhagic conjunctivitis in Delhi in 1994. *Indian J Ophthalmol* 1996; 44: 19-21.
- Yin-Murphy M, Lim KH, Ho YM. A coxsackievirus type A24 epidemic of acute conjunctivitis. *Southeast Asian J Trop Med Public Health* 1976; 6: 1-5.
- Chang CH, Lin KH, Sheu MM, Huang WL, Wang HZ, Chen CW. The change of etiological agents and clinical signs of epidemic viral con-