

*Related outbreak of epidemic keratoconjunctivitis in an ophthalmology practice and a general hospital are described. The apparent cause of initial spread was inadequate cleansing of hands or instruments. The implications for screening programs for glaucoma are clear.*

## **EPIDEMIC KERATOCONJUNCTIVITIS**

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**E**PIDEMIC keratoconjunctivitis (EKC) was first described in 1889.<sup>1</sup> By 1930, a viral etiology was suggested<sup>2</sup>; in 1955 adenovirus type 8, the most common etiologic agent, was first isolated from a patient.<sup>3,4</sup> Subsequently, adenovirus types 2, 3, 4, 7, 10, 14, 16, and others have been shown on occasion to cause EKC.<sup>5,6</sup>

Outbreaks were first noted in naval shipyards during World War II.<sup>7</sup> It was these frequent outbreaks that gave the disease the common name "shipyard eye."<sup>8</sup> Subsequent outbreaks have been reported among workers in various trades where eye injuries are a frequent occurrence.<sup>9,10</sup> A common place for outbreaks of EKC has also been among patients in ophthalmology practices.<sup>9,11,12</sup>

In Western Europe and the United States the disease is seen primarily in adults and occurs in sporadic outbreaks. Surveys of selected populations in the United States and Italy showed only a small proportion with antibody to adenovirus 8; approximately 5 per cent were seropositive.<sup>13,14</sup>

In contrast, Asian countries, especially Japan,<sup>15</sup> Taiwan,<sup>6</sup> and Malaysia<sup>16</sup> have reported city-wide outbreaks and endemic disease without particular relationship to occupation, eye examination, or age. Studies of selected populations in Japan and Taiwan have shown anti-

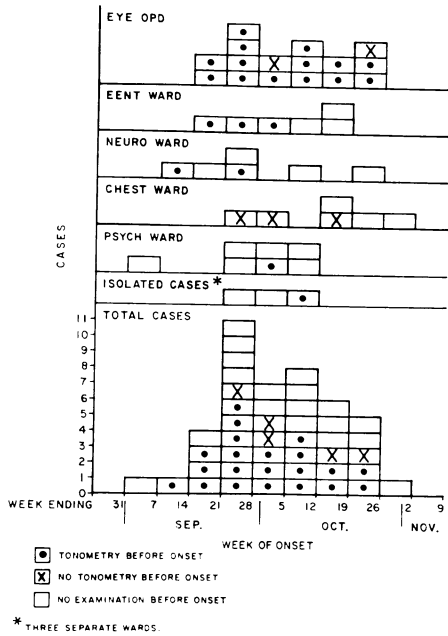
body present in a large proportion of those tested, about 30 per cent<sup>14,17</sup> and 60 per cent,<sup>18</sup> respectively. Children in these countries frequently manifest disease. They tend, however, to have a systemic disease with only a mild conjunctivitis and are believed to act as a reservoir for the large outbreaks.<sup>15,17,19,20</sup>

Where the disease occurs in large numbers, a seasonal pattern sometimes emerges. In Taiwan, for example, the disease has a late summer-fall peak with few cases reported in the winter.<sup>6</sup> In Malaya, where the disease is also endemic, no seasonal pattern is seen.<sup>16</sup>

EKC is most severe in adults. The incubation period has been estimated at 7-14 days, usually 7-10 days. The sensation of a foreign body in the affected eye(s) commonly marks the onset of symptoms. This is followed within a day by generalized conjunctivitis, a mucoid (not purulent) discharge, and profuse lacrimation. Within the next several days, large smooth follicles develop on the conjunctiva. In some cases preauricular adenopathy develops one or two days after the onset of conjunctivitis. In about half of the cases bilateral disease is seen.

Subepithelial infiltrates, the hallmark of this disease, develop in the cornea of half or more patients 10-14 days after onset of disease. Although this can cause

**Figure 1—Incidence of epidemic keratoconjunctivitis by patient care unit in a general hospital outbreak, September 1-November 2, 1968**



tinely examined in this clinic if at all possible. Therefore case finding initially included an interview with the two ophthalmology residents, in which they were asked to recall patients' names, and a hospital-wide survey by the nursing staff to collect information on all cases of conjunctivitis that had occurred in patients during the preceding six weeks. Subsequently, the names of all new patients and of persons returning to the clinic for follow-up exams were kept in a log by the physicians.

Sixteen patients who visited the eye clinic between the first week in September and the first week in October are known to have subsequently developed EKC. Fourteen of these 16 had tonometry, but the other two had no known instrumentation (Figure 1). Each ophthalmology resident had one Goldman Applanation tonometer. They did not wash their hands routinely after examining each patient. They wiped the

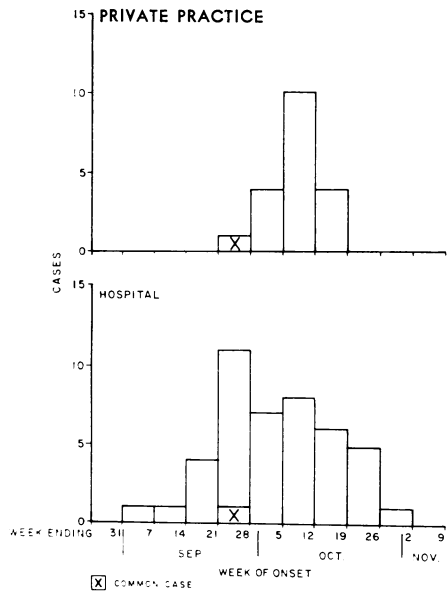
blurring of vision or photophobia, patients frequently are unaware of the keratitis. Keratitis is seen rarely in patients under ten years of age.

On successive days in early October, 1968, a general hospital and a private ophthalmologist each reported suspected outbreaks of epidemic keratoconjunctivitis to the New York City Department of Health.

### Outbreak in a General Hospital

The first known case in the hospital had onset on September 1, 1968, as shown in Figure 1. The outbreak was not recognized, however, until five weeks later, after several cases had been seen in the ophthalmology outpatient clinic. This hospital does not maintain a log of patients seen in the eye clinic, and all inpatients and outpatients are rou-

**Figure 2—Related outbreaks of epidemic keratoconjunctivitis, September 1-November 2, 1968**



**Table 1—Epidemic keratoconjunctivitis, cases by day of exposure and by tonometry in a private ophthalmology practice**

Day	Dr. A*				Dr. B			
	Tonometry		No tonometry		Tonometry		No tonometry	
	Exams	Cases	Exams	Cases	Exams	Cases	Exams	Cases
1	4	4†	7	0				
2	7	5	5	0				
3	5	0	5	0				
4					7	3†	5	0
5-8	HOLIDAY		HOLIDAY		HOLIDAY		HOLIDAY	
9	6	3	4	0				
10	0		9	0				
11					10	0	9	0
12-13	WEEKEND		WEEKEND		WEEKEND		WEEKEND	
Total	22	12	30	0	17	3	14	0

\* EKC onset day 11.

† Wife of one patient also contracted EKC.

tonometer head, which was plastic and removable, with a dry tissue after use. Once the outbreak had been recognized, both doctors began washing their hands and tonometers with hot water and soap after each examination. No new cases developed in patients seen in the clinic after these precautions were instituted.

While the eye clinic was experiencing the outbreak of EKC, the EENT and neurology wards had similar outbreaks. In both instances, the first known case on the ward occurred in a patient who had had tonometry performed by one of the ophthalmology residents using the clinic instruments (Figure 1). The remaining cases on these wards occurred either subsequent to an exam by an ophthalmologist or to contact with a known case. The first three patients affected on the chest ward had recently had eye examinations but without instrumentation. The subsequent three cases on this ward occurred in ward staff members.

Seven patients on the psychiatry ward, a closed ward with much patient interaction, contracted EKC. All of the patients had been on the ward a minimum of six weeks, and only one, chronolog-

ically the fourth, had been examined by an ophthalmologist. Finally, a case of EKC occurred on each of three separate wards where no related cases could be found. Only one of these three patients had had an eye examination.

An informal telephone survey of ophthalmology clinics and ophthalmologists in the same borough as this hospital revealed no suggestion of a concurrent community-wide outbreak of EKC.

### Outbreak in an Ophthalmology Practice

In the course of the hospital outbreak, a glaucoma patient who was under the care of a private ophthalmologist was examined twice in the hospital eye clinic. He subsequently developed EKC and was seen the day after onset of symptoms by Dr. A., his private ophthalmologist. Since the patient presented with a red eye, tonometry was performed to exclude the possibility of an acute glaucoma attack. No special precautions were taken following tonometry. This glaucoma patient became the seed case to a second outbreak of EKC in the private office of two ophthalmologists, Dr. A. and Dr.

B. The time relationship between the two outbreaks can be seen in Figure 2.

Dr. A. and his colleague did not routinely wash their hands after examining each patient. Each physician had three Schiøtz tonometers which he wiped with dry tissues after each examination. Each night the tonometer used that day was placed in a Romer ultraviolet sterilizer for 15 to 30 minutes. Each morning the tonometer to be used was wiped with ether. The physicians examined patients on different days in the same room, using the same equipment with the exception of tonometers.

The attack rates by date of exposure for this outbreak are shown in Table 1. Examination of this table reveals:

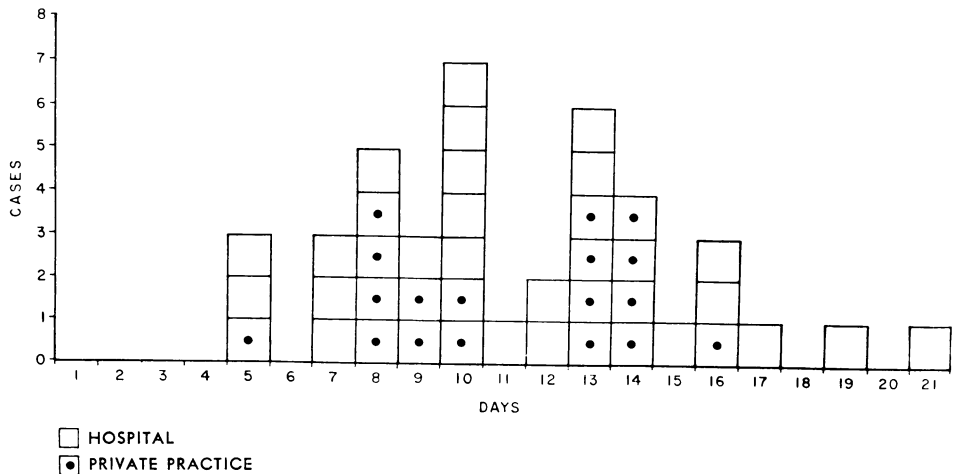
1. Cases occurred exclusively in patients who had tonometry performed on day 1, 2, 4, or 9. (Day 1 is the day the seed patient was examined by Dr. A.)
2. No cases developed in patients seen day 3, although tonometry was performed that day.
3. Cases occurred in patients seen day 4, although Dr. B. presumably does not use Dr. A's tonometers.
4. Cases occurred in patients seen on day 9 after the office had been closed for a four-day holiday.

Dr. A. maintains another office in another part of the city. No cases occurred among the patients examined in this second office, although he continued to see patients throughout the period of the outbreak in the first office and for at least three days after the onset of his own disease symptoms (day 11). Beginning day 10, however, Dr. A. stopped instrumentation of all patients in both practices. As cases of EKC continued to be seen and in light of his own diseased eye, he decided to close both practices for two weeks. No cases, however, developed in patients examined after day 9. Dr. B. continued his practice unchanged and had no cases occur among his patients after day 4.

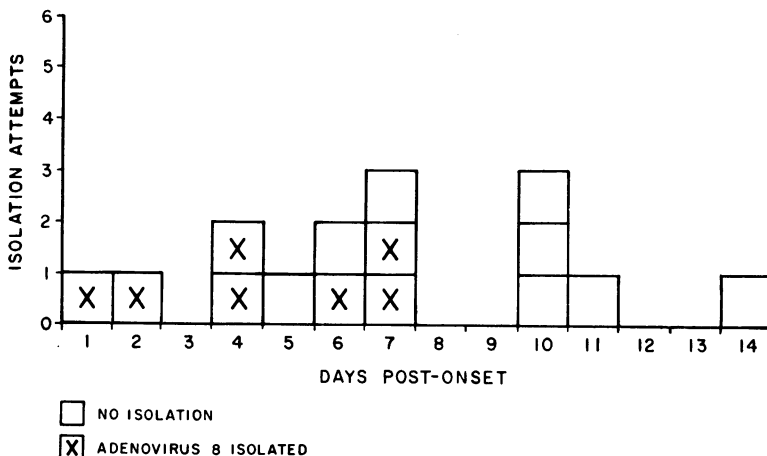
Observations

*Incubation Period*—The incubation period for the disease was tabulated for all patients who had only a single possible exposure. All persons with more than one exposure in the month preceding onset of disease and all those with possible other exposures (e.g., hospital

Figure 3—Incubation period of epidemic keratoconjunctivitis cases with known single exposure



**Figure 4**—Number of isolates of adenovirus 8 from conjunctiva of patients affected with epidemic keratoconjunctivitis by time of collection



inpatients) were excluded. The median incubation period observed in both outbreaks was 10 days (Figure 3). The incubation period for hospital clinic cases ranged from 5 to 21 days and for private patients from 5 to 16 days.

**Clinical Features**—In both outbreaks, most patients presented with a mild conjunctivitis. Those who had glaucoma presented with bilateral disease. In the hospital outbreak, 31 of 44 (70%) eventually developed bilateral disease. The conjunctivitis was frequently follicular and inconstantly associated with preauricular adenopathy. Keratitis developed in 32 of 44 (73%) of the patients. Owing to the prevalence of EKC, as the epidemic progressed, the disease was labeled without clinical elaboration in the private ophthalmologists' records. Tabulation of clinical features for these patients consequently could not be undertaken.

### Laboratory Studies

Laboratory studies were performed on specimens taken from patients involved in both outbreaks. Conjunctival swabs were collected in Eagles Minimum Es-

sential Medium and transported immediately in wet ice, or frozen and transported in wet ice, to the laboratory. Specimens were inoculated into a variety of cell cultures and isolated in human embryonic kidney cells, African green monkey cells, and/or diploid WI-38 cells.

Isolates were identified by the hemagglutination inhibition (HI) procedure of Ginsberg<sup>21</sup> using reference antisera. No virus was isolated from specimens collected after the seventh day of disease (Figure 4).

HI serologic studies were done on paired sera as outlined by Rose.<sup>22</sup> Of the 16 patients studied, 10 demonstrated seroconversion.

There was the possibility that the two outbreaks reported here were part of a city-wide outbreak of adenovirus type 8. To test this hypothesis, a serologic survey was carried out. Every month the Virus Unit in the Bureau of Laboratories randomly selects blood specimens in each of six age groups from the specimens received and screened for syphilis. These blood specimens are predominantly from persons applying for marriage licenses.

For this study, 25 specimens were ran-

domly selected from age groups 15-19 years and 40-49 years for the months of September and November, 1968. These were then tested for HI antibody. There was no evidence of a city-wide outbreak of adenovirus type 8 infection (Table 2).

**Discussion**

Although outbreaks of EKC in eye-hospital populations have been reported,<sup>23-25</sup> this is believed to be the first to be noted in the patient population of a general hospital. Those known to have contracted EKC when examined as outpatients were exposed, in all but two instances, to instruments which probably were contaminated. The other two patients had not been examined with instruments, but it has been shown that finger-to-eye contact can spread EKC,<sup>9,23</sup> and it is thought that one of the ophthalmologists directly infected these two patients.

The outbreaks on the different wards illustrate several points. The common mode of introduction and spread is exemplified by the small outbreak on the EENT ward. The patients initially infected by tonometry were the source of subsequent cases probably through finger-to-eye contact.

The outbreaks on the EENT and neurology wards were confined to patients. However, on the chest ward three staff members were infected which clearly illustrates the potential danger to hospital staff as well as to patients. Even the maintenance of strict sanitary practices may not avert the unconscious finger-to-eye motion.

The explanation of the outbreak on the psychiatry ward remains incomplete. Only one of the seven affected had been examined by an ophthalmologist, and his disease onset occurred well along in this ward's outbreak. Since all known patients with EKC infection had resided on this ward for at least six weeks, none could be identified as an index case. The ex-

planation probably resides in cases not detected by our investigation.

Of particular interest in the hospital outbreak is the large number of affected persons who had not been examined by ophthalmologists. Of the 44 known to have contracted conjunctivitis, 18 (40%) were not apparent iatrogenic cases.

The outbreak in the private practice presented several questions for which there is reasonable speculation. The absence of cases in patients seen on day 3 is probably due to the use of a different tonometer. Dr. A. had no routine rotation of tonometers. The presence of patients affected with EKC in only one day of Dr. B.'s practice suggests that Dr. A.'s contaminated tonometer was used in error. Both doctors used the same topical anesthetic, but this unfortunately was no longer available for culture. However, had it been the anesthetic that was contaminated, then cases should have occurred in patients seen on day 3.

The occurrence of cases on day 9, following four days of holiday, suggests that the virus on the contaminated tonometer(s) survived either in ocular fluid or in a dry state. Studies have shown that adenoviruses are hardy enough to survive for long periods at room temperature<sup>26,27</sup> and for at least 24 hours in a dry environment.<sup>28</sup> An alternative explanation is that Dr. A. directly contaminated his patients from his own in-

**Table 2—Presence of adenovirus type 8 HI antibody in randomly selected blood specimens in two age groups for September and November, 1968**

Age	HI Titers 1:10			
	September		November	
	Number specimen	Number >1:10	Number specimen	Number >1:10
15-19	25	1	25	0
40-49	25	0	25	1

fectured eye, which became symptomatic two days later.

The matter of controlling epidemic keratoconjunctivitis outbreaks and preventing their occurrence is important. In the outbreaks reported here, two very busy practices were severely disrupted and one closed for two weeks. Many different methods have been applied to prevent or control outbreaks. Pelliteri and Fried<sup>12</sup> and Singh<sup>16</sup> used sterilized instruments for each patient. Both nurse and physician washed hands between patients. Patients were instructed to touch only personal articles when in the physician's office, to use tissue instead of handkerchiefs, and to use individual towels, pillow covers, and sheets. Laibson, et al.,<sup>24</sup> discontinued routine tonometry, had the tonometer flame-sterilized after each patient, and had the slit-lamp ocular pieces cleaned with 95 per cent alcohol daily. All staff members were cautioned about touching or rubbing their own eyes.

In addition to the above control measures, Kjer and Mordhorst<sup>25</sup> discontinued all elective intrabulbar operations.

In the hospital outbreak reported here, hand washing and vigorous instrument washing appeared to stop the outbreak in the eye clinic. In the private practice, daily ether washes and ultraviolet light treatment apparently did not prevent the transmission of disease. Ether is known to have no effect on the survival of adenoviruses.<sup>27</sup> Ultraviolet light sterilization has previously been reported as ineffective due to technical shortcomings.<sup>23</sup>

Good personal hygiene and appropriate cleansing of instruments would appear to succeed in preventing or in curtailing outbreaks of EKC. Tonometers with plastic heads should be washed vigorously with soap and water after each exam. Tonometers with metal heads should be flame-sterilized after each exam, or a disposable tonofilm should

be employed. Hands should be washed before each examination. Failure to apply such simple precautions with compulsive regularity can result in clearly preventable outbreaks of EKC.

### Summary

In an outbreak of epidemic keratoconjunctivitis in the eye clinic and on seven wards of a general hospital, 44 persons—patients and staff members—are known to have been affected, 40 per cent without previous eye examination. A patient seen in the hospital clinic was the seed case for an outbreak in a private ophthalmology practice, which caused 18 cases including one in a physician.

In both instances, inadequate cleansing of instruments or inadequate hand washing, or both, with soap and water was apparently the initial cause of spread. Subsequent transmission of EKC in the hospital wards apparently resulted from direct hand-to-eye contact among patients and staff members. Adenovirus type 8 was isolated in both outbreaks.

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