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Pertussis Outbreak in Austin and Travis County, Texas, 1975

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An outbreak of bacteriologically proven pertussis occurred in Austin and Travis County, Texas, over a 7-month period in 1975. Eighty persons were cultured for pertussis in our laboratory. A total of 62% of specimens from 34 individuals with suspected pertussis was positive for *Bordetella pertussis*. Diagnosis of acute cases by both culture and fluorescent antibody was attempted, and the correlation of the methods is given. Analyses of cases by age, sex, immunization status, and antibiotic treatment prior to culture are included in this report. Two asymptomatic, culture-positive adults were found.

Although the morbidity and mortality due to pertussis have steadily decreased, the disease still affects several thousands of persons each year. In 1974, 2,402 cases were reported in the United States (10). This reported number undoubtedly reflects a small proportion of the actual numbers of cases. Pertussis is a serious disease in infants less than 1 year old and can cause death or prolonged illness with serious complications (27). Recent reports indicate that pertussis can be a significant epidemiological problem for adults as well as children (7, 21, 22, 24-27). Adults with unrecognized disease can easily act as vehicles of transmission for the infection (21, 24, 25).

Studies have shown that the best vaccines do not afford 100% protection (5, 8, 22, 27, 30, 32). Furthermore, the level of immunization of different populations or socioeconomic groups varies. Regardless of immunization status, attack rates are especially high in household contacts of persons ill with the infection (27).

As in other states, pertussis continues to be a problem in Texas. Figure 1 summarizes the reported pertussis cases (not all culturally confirmed) in Texas and Travis County within the past 10 years. Although the levels of immunization of the entire state are not known, recent household index surveys for two Texas cities (Dallas and San Antonio) indicate diphtheria-pertussis-tetanus (DPT) immunization levels of 81 and 50%, respectively (12, 31). The most recent Immunization Index Survey in the city of Austin (1968) indicated an immunization level of 76% among children 1 through 6 years of age (3).

This report describes an outbreak of bacteriologically proven pertussis that occurred in the city of Austin and surrounding Travis County, Texas, over a 7-month period in 1975. It includes results of cultural findings and analysis of cases by age, sex, immunization status, and antibiotic treatment received before culture.

MATERIALS AND METHODS

History. The outbreak in Travis County occurred over at least a 7-month period from April through November 1975. Patients with a suspected diagnosis of whooping cough or family contacts of patients were referred to our laboratory for cultures by Brackenridge Hospital Outpatient Clinic and Pediatric Unit by the Austin-Travis County Health Department and by private pediatricians. Public Health nurses from the Austin-Travis County Health Department followed up each confirmed case, interviewing and taking histories of household members and contacts. All patients and family members described in this report were residents of Travis County.

Collection and transport of specimens. Pernasal nasopharyngeal swabs (Ultrafine Calgiswab, Inolex Corp.) were collected and processed as outlined by Pittman (28). Separate pernasal swabs were taken from the right and left nostrils of each patient. One swab was placed into 0.5 ml of 1% Casamino Acids solution (pH 7.0), and the other was placed into 0.5 ml of an experimental synthetic holding medium. The synthetic holding medium consisted of a salt solution as described by Stanier and Scholte (33) solidified with 0.5% agarose. This medium gave results equivalent to the 1% Casamino Acids solution. Smears of exudate for the direct fluorescent-antibody (FA) test were prepared from the Casamino Acids solution. Most swabs were streaked immediately, and none was held in transit longer than 2 h before plating.

Isolation and identification. For isolation and identification, each swab was streaked onto two freshly poured Bordet-Gengou (BG) plates, one of which contained 2.5 μg of sodium methicillin (Celbenin, Beecham-Massengill Pharmaceuticals) per ml. (Methicillin rather than penicillin was recommended by Larry Baroff, University of Southern California Medical Center.)

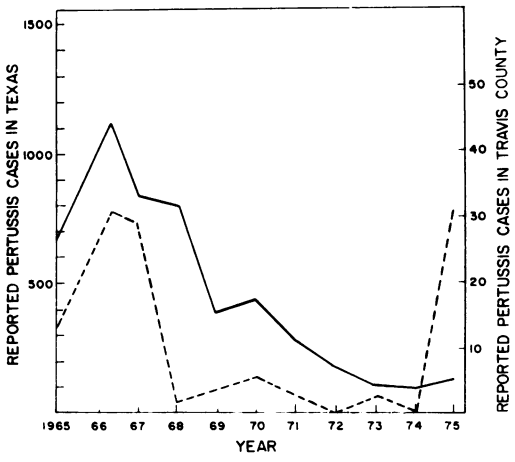

FIG. 1. *Reported pertussis cases in Texas and Travis County, 1965 to 1975. Statistics were obtained from the Texas Department of Health Resources. Symbols: ——, Texas total; -----, Travis County totals.*

BG base (without peptone) was prepared "homemade" from potatoes as follows: 187.5 g of peeled, diced potato was boiled in 1,500 ml of distilled water, and the resulting liquid was filtered through several layers of cotton gauze. To 1,000 ml of potato-water filtrate was added 15 ml of glycerol (Difco Laboratories), 9.97 g of NaCl (Reagent, A.C.S.), and 30 g of agar. The pH was adjusted to 7.0, and the base was autoclaved. For use, 30 ml of defibrinated sheep blood was added per 100 ml of molten base, and plates were poured and used fresh.

Plates were incubated for 1 week at 35°C in a sealed container to prevent moisture loss. They were examined daily at 7× magnification with a stereoscopic microscope, using oblique light from above, for typical *Bordetella pertussis* colonies. Suspicious colonies were picked and Gram stained. If gram-negative rods or coccobacilli were seen, FA stains were performed to identify *B. pertussis*. All our isolates were referred to the Texas Department of Health Resources Laboratory for confirmation.

Serological methods. Rabbit antiserum was prepared by using, as antigen, a mixture of standard laboratory strain 10536 and two fresh, clinical isolates. Rabbits were pre-bled before immunization and tested for antibodies to *Bordetella bronchiseptica*, and only those with a titer of less than 1:4 were used. The antigen consisted of 10^9 live cells per ml suspended in phosphate-buffered saline. Injections were given intravenously at 3-day intervals according to the following schedule (courtesy B. Pittman, CDC): (i) 0.5 ml; (ii) 1.0 ml; (iii) 2.0 ml; and (iv) 1.6 ml (for six injections). The rabbits were test bled 7 to 10 days after the last injection. The agglutination titer of the serum was determined against *B. pertussis*, *B. parapertussis*, and *B. bronchiseptica* by the method of Eldering et al. (13) and was found to be satisfactory for use in identification of *B. pertussis*.

An FA conjugate was prepared from the antiserum according to the procedure of Herbert et al. (17). The conjugate had a final fluorescein/protein ratio of 25 μg of bound fluorescein isothiocyanate per mg of protein per ml of conjugate. The procedure for direct FA staining was carried out as outlined by Pittman (28). Slides were read with a Zeiss large fluorescence microscope equipped with an HBO 200 mercury arc lamp. Filters used were a BG 38 (red absorbing filter), BG 12 (primary filter), and Zeiss 43/56 (secondary filter).

Serotyping was performed (13) on a limited number of strains from five unassociated outbreaks with factor-specific typing sera obtained from the Division of Biologic Standards, Food and Drug Administration (courtesy of Charles Manclark).

RESULTS

Culture results. A total of 80 individuals were cultured during the epidemic. Of the 80 persons: (i) 34 persons were diagnosed as, or suspected of having pertussis; (ii) 7 persons had other diagnoses, and cultures were requested to rule out pertussis; and (ii) 39 persons represented contacts of suspected or diagnosed pertussis cases. Of the 34 individuals cultured for suspected pertussis, 20 were culture positive (59%). Some of these patients were in the third to fifth week of symptoms, and many had been treated with antibiotics before culture. One specimen, from a child who had culture-positive siblings, was culture negative, but positive by the direct FA test. Thus, the total number of specimens identified as positive for *B. pertussis* from suspected cases was 21 (62%). No isolations of *B. pertussis* were made from the seven persons having diagnoses other than pertussis. Two isolations were made from the 39 contacts. *B. parapertussis* was not isolated from any of the specimens. Viral isolation from the specimens was not attempted.

Public Health nurses investigated each household in which a culture-positive individual lived. Table 1 summarizes the investigation of 16 households composed of 97 individuals. These families represented at least 15 unrelated clusters. A total of 40 of the 97 persons had symptoms suggestive of pertussis. A total of 21 of the 40 were culture or FA positive, 5 were culture negative, and 14 were not cultured. *B. pertussis* was isolated from 2 of 21 asymptomatic family members cultured.

Although nasopharyngeal swabs were taken from both nostrils of each individual, in two cases *B. pertussis* was isolated from only one of the swabs. In one instance, the positive swab was from the Casamino Acids solution, and in the other instance, it was from the synthetic medium. Thus, 2 of 20 positive cultures from cases could have been missed if only one side of the nares had been swabbed.

TABLE 1. *Summary of culture and immunization history for all household members of the 16 households that had at least one positive pertussis culture*

Culture status	Immunized[a]	Nonimmunized[b]
Symptomatic individuals[c]		
Culture or FA positive	4	17
Culture negative	3	2
Not cultured	6	8
Asymptomatic individuals		
Culture positive		2
Culture negative	5	14
Not cultured	15	21

[a] Immunized individuals had received a complete DPT series.

[b] Nonimmunized individuals include those who had not been immunized, or those who had not received a complete immunization series or whose immunization status was not known.

[c] Symptomatic individuals are defined as those giving a history of pertussis-like illness at the time of, immediately preceeding, or within 4 weeks after culture of the index case.

The use of BG plates containing 2.5 μg of methicillin per ml was important in successful isolation of the organism. Although the growth on BG+ methicillin was somewhat slower, pure cultures of *B. pertussis* were obtained in numerous cases. In all cases, use of methicillin greatly reduced the overgrowth of other organisms. In 6 of 22 positive cultures (including one asymptomatic adult and 5 cases), BG+ methicillin was the only culture medium yielding detectable colonies of *B. pertussis*. Charlvardjian has also reported the superior action of methicillin in BG plates (11). In 1 of the 22 positive cultures, growth of *B. pertussis* was obtained only on the BG without methicillin plates.

Asymptomatic culture-positive adults. In two instances, positive pertussis cultures were obtained from asymptomatic adults. One culture was from a 34-year-old female – the aunt and household contact of two culture-positive children. The culture from the aunt was taken 4 days after culture of the children. The other positive culture was from a 26-year-old woman whose 2-month-old infant became symptomatic 2 August 1975. Although a clinical diagnosis of pertussis was made, the infant was culture and FA negative during hospitalization from 14 to 21 August. On 23 August, a culture of the mother was positive for pertussis. For this report we will refer to these two individuals as pertussis carriers. We define a carrier as a culture-positive, asymptomatic individual.

Correlation of culture and FA results. A limited number of direct FA tests were performed on smears of nasopharyngeal exudate from acutely ill infants and children. The correlation between positive cultures and positive direct FA tests is shown in Table 2. Although we cultured 34 patients with a suspected diagnosis of pertussis, parallel FA tests were done on only 15 of these patients. Of the 15 parallel culture-FA tests performed, 10 (67%) were positive by culture, whereas only 4 (27%) were positive in the direct FA test. One case was positive only by the direct test.

Use of FA in cultural diagnosis. The FA test was also used to identify suspected pertussis colonies on BG plates. It could be used to examine very small colonies after 2 days of incubation of the plates and usually shortened the time required for a positive report. The use of the FA test in this way has been reported by other workers (11, 18).

Serotyping. Seven isolates representative of 5 of the 15 clusters were serotyped. All serotyped as 1,3,6 in agreement with the currently observed serotype patterns of *B. pertussis* in the United States and other parts of the world (2, 6, 14, 25, 29, 30, 32).

Date of onset. Figure 2 shows the date of onset for pertussis-positive individuals. The two asymptomatic adult females are included by date of positive culture. One was culture positive in May, whereas the other was culture positive in August.

Age distribution. Table 3 shows that a positive culture was more likely to be found in younger children than in older ones. The mean age of the culture or FA-proven cases was significantly lower than the mean age of those who were culture negative but were symptomatic. All culture-proven cases occurred in children 6 years of age or younger.

Sex distribution. The sex distribution of the 23 culture- or FA-positive cases and carriers was as follows. A total of 14 individuals, including 12 cases (52%) and 2 carriers (9%) were female, whereas 9 cases (39%) occurred in

TABLE 2. *Results of specimens examined both by the direct FA test and by culture from 15 suspected pertussis cases*

Testing method	No. positive	Percent positive
Culture positive, FA positive	4	27
Culture positive, FA negative	6	40
Culture negative, FA positive	1	6
Culture negative, FA negative	4	27
Total positive	11	73

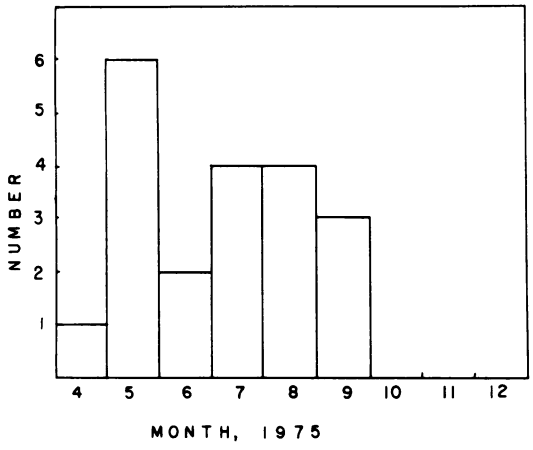

FIG. 2. *Date of onset for pertussis-positive individuals. All individuals were culture or FA positive for B. pertussis. Two culture-positive, asymptomatic adults are included by date of positive culture.*

TABLE 3. *Correlation of age with positive identification of pertussis in symptomatic individuals*[a]

Culture or FA status	No.	Mean age[b] (yr)	Age range
Positive	21	1.6	4 weeks–6 years
Negative	13	3.8	3 weeks–23 years

[a] These individuals all had symptoms of pertussis and were referred specifically for pertussis cultures. No asymptomatic contacts or carriers are included. Some individuals had received antibiotic treatment before culture.

[b] Results significant at $P \leq 0.02$ by the two-sample rank test (30).

males. It is well documented that pertussis attack rates are higher in females than in males (5, 8, 16, 19, 27).

Immunization status. Four individuals of the 21 culture- or FA-positive cases were immunized. Three of these (all 2 years of age) had completed a primary DPT series. The fourth, 6 years of age, had completed the primary series and received a booster early in 1975. Thirteen individuals were unimmunized. These included six infants 5 months old or younger, who had not begun the DPT series. Four children were partially immunized. These included a 6-month-old infant who developed pertussis 2 weeks after the second DPT shot and a 7-month-old infant who developed pertussis 1 month after the second DPT shot. The immunization status of the two carriers could not be determined with certainty.

Antibiotic treatment before culture. Antibiotic treatment before culture of the 34 individuals with clinical pertussis is shown in Table 4. Of the 21 positive cases, 9 (43%) had received ampicillin before culture. In contrast were the 6 (29%) patients who received erythromycin, erythromycin plus ampicillin, or tetracycline before culture. Only one of these (5%) was culture positive, although all had clinical pertussis.

Duration of symptoms at time of positive culture. Cultures were performed at various times after symptoms began, depending on when the individual was seen by a doctor. Of the 21 culture- or FA-positive cases, 11 had been symptomatic one week or less before culture; 3 had been symptomatic between 1 and 2 weeks; 6 were in the third week; and 1 was in the fifth week.

Severity of illness. A total of 5 of 21 culture- or FA-positive cases (24%) required hospitalization; 2 were in the intensive care unit. A total of 3 of the 5 were under 6 months of age. An additional 2-month-old child, diagnosed as having pertussis clinically, and whose mother was a carrier, had repeated episodes of cardiac and/or respiratory failure and was hospitalized in the intensive care unit also. One other child was hospitalized in the intensive care unit with a clinical diagnosis of pertussis before culture procedures were available.

DISCUSSION

Our results indicate that Austin experienced an outbreak of pertussis in 1975. According to local physicians, it has been a number of years since pertussis of this severity and frequency has been seen in the Austin-Travis County area. There had been no hospital admissions diagnosed as pertussis before 1975 for at least 5 years.

An accurate calculation of pertussis incidence is difficult. In families where a confirmed case (culture or FA positive) occurred, retrospective histories reveal an apparent attack

TABLE 4. *Antibiotic treatment received before culture of persons with clinical pertussis*

Culture	No.	Antibiotic treatment[a]					
		Amp	Pen	Ery	Ery + Amp	Tet	None
Positive	21	9	1[b]	1	0	0	10
Negative	13	0	0	2	2	1	8

[a] Amp, Ampicillin; Pen, penicillin; Ery, erythromycin; and Tet, tetracycline.

[b] Patient being treated for impetigo at time of pertussis culture.

rate of about 40%. If we assume that the clinical diagnosis of pertussis in 34 persons represents all cases in a population of 295,516 (9), then the incidence of pertussis is 11.5 per 100,000 for 1975.

In interviewing the persons we cultured, we found that they often knew of similar illnesses in neighborhood, church, or school contacts. We also noted that many children seen by physicians were referred for culture only after unsuccessful antibiotic therapy or development of a typical whoop. Thus, the culturally confirmed cases probably represent only a small proportion of the actual cases. These observations, coupled with the abrupt reappearance of pertussis, the severity of disease in many children, and the widespread distribution (15 clusters) indicate that an epidemic occurred.

In contrast to the conclusions drawn by Olson in his recent review (27), we found a combination of culture and FA staining to be an efficient method to confirm a clinical diagnosis of pertussis. A total of 62% of children suspected of having pertussis on clinical grounds in this study were culture or FA positive.

With the availability of good laboratory techniques (28), a physician need not rely on clinical observations alone to diagnose pertussis. In small infants, and in those older than 12, classical symptoms may not always be manifested. In several recent reports (21, 25), pertussis cases have been found in adults only after transmission to children. Cultural confirmation of one pertussis case in a family allows the physician to diagnose pertussis more easily in family members and contacts, and to use chemotherapeutic and chemoprophylactic agents to eradicate sources of infection. Confirmed cases occurring in the community also alert local pediatricians to consider pertussis as a possible diagnosis.

In our experience, for the optimum recovery or identification of *B. pertussis*, we suggest the following modifications of the accepted method (28): (i) two properly collected pernasal nasopharyngeal swabs (one taken through each nostril), placed in separate tubes of 1% Casamino Acids solution; (ii) plating as soon as possible (2-h limit) on multiple "homemade" BG plates with and without methicillin; (iii) daily observation of the plates with a stereoscopic microscope with oblique light from above, beginning at 48 h; and (iv) use of fluorescent antibody staining to identify suspicious *B. pertussis* colonies. We have found, as have other workers (11, 18), that this allows positive identification and reporting of pertussis within 48 to 72 h.

Our results indicate that whereas direct FA staining of nasopharyngeal exudate can complement cultural diagnosis, it should not be substituted for culture. When compared with culture, the direct FA test only identified 40% of culture-positive individuals. The advantage of direct FA staining is that, when positive, it can provide the physician with information in a short period of time. This is particularly valuable in the diagnosis of acutely ill infants and children. The variable success of the direct FA test reported by others in the literature is almost certainly due to the lack of standardization of the FA conjugates used by various workers. Since it is impossible to purchase consistently good reagents from commercial sources, and the quality of individually prepared reagents will vary, inconsistent results from direct FA testing will probably continue to be a problem in the future.

We cannot conclude as did Olson (27) that pertussis "no longer represents a serious health problem." A total of 24% of culture- or FA-positive cases in this report were hospitalized. Several of these children were critically ill.

Our results indicate that ampicillin is ineffective in eliminating pertussis organisms from the nasopharynx. A total of 43% of culture- or FA-positive cases had received ampicillin before culture. Other workers have shown the ineffectiveness of ampicillin (1, 4, 19, 21, 24, 34). In contrast, recent reports of pertussis outbreaks have shown the usefulness of erythromycin in eliminating the organisms from the nasopharynx (4, 19, 21, 24, 25). Our results add support to others that erythromycin is the current drug of choice for treatment of pertussis.

In every community, a population susceptible to pertussis exists. We found disease in children too young to be immunized, as well as in fully immunized children and those partially or not immunized. Even communities with good levels of immunization are not necessarily safe from pertussis outbreaks.

Changes in the epidemiology of pertussis are to be expected in light of nearly universal childhood immunization. With the decline in childhood cases in recent years, an increased susceptibility to infection in older individuals might be expected. Continued surveillance and culture are important in detection of any changes in the disease pattern. In our study, case follow-up histories suggested that about half the cases in children followed contact with adults or teenagers showing respiratory symptoms. This observation is interesting, but we have no good evidence to support transmission of pertussis by adults and teenagers in this outbreak. However, culture-positive, asymptomatic adults were discovered.

Two adults in contact with pertussis patients were found to be culture positive but asymptomatic. These women had no symptoms of illness either before, or for 4 to 6 weeks after, culture. They were not taking antibiotics during this time. It was not possible to confirm whether either had been immunized or had experienced whooping cough as a child. Unfortunately, we were unable to obtain follow-up cultures from the women to determine the duration of the carrier state.

Whereas there has been one report of asymptomatic, culture-positive children documented in the literature (22), this is the first report of asymptomatic adult carriers since the advent of pernasal nasopharyngeal swabs and the FA technique. Gorden et al. (16) discussed the early papers reporting carriers of pertussis. We feel, as did Gordon and his co-workers, that early reports of adult carriers were unreliable in light of current technical advances in diagnosis and identification of *B. pertussis*.

It is not clear whether the adult carriers in our study infected the children or were infected by the children. However, the fact that asymptomatic persons can harbor pertussis in their nasopharynx provides evidence that a reservoir of adult carriers may exist. Since pertussis occurs sporadically in children even in areas of "adequate" immunization, it is likely that there is a reservoir (such as adults and teenagers). We feel that a larger study to investigate this suggestion might be fruitful.

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