

# Epidemic Measles in a Divided City

Philip J. Landrigan, MD

Between June 1970 and January 1971, 633 cases of measles occurred in Texarkana, a city bisected by the Texas-Arkansas state line.

A total of 606 (95.7%) of the cases occurred in Texarkana (Bowie County), Tex, a community that had never had a measles vaccination campaign. The level of prior immunity, natural plus vaccine-induced, in the 11,185 children aged 1 to 9 years in Bowie County was estimated to be 57%. Only 27 cases occurred in Texarkana (Miller County), Ark, where more than 95% of the 6,016 children aged 1 to 9 years were immune. Nineteen of the 27 Arkansas patients had documented exposures in Texas.

Twenty-seven cases of measles occurred in previously vaccinated children. Six of these children had received vaccine with measles immune globulin prior to 1 year of age. Vaccine efficacy was calculated to be 95.9%.

Since 1967, measles has been re-surgent in the United States. The number of reported cases has risen from 22,231 in 1968 to 42,043 in 1970,<sup>1</sup> and by July 1 more than 63,000 cases had been reported for 1971.<sup>2</sup> Some of the recent cases occurred in children previously vaccinated against measles, causing doubt about the effectiveness of live, attenuated, measles virus vaccine. It has become necessary to redefine the epidemiology of measles and to reevaluate the effectiveness of measles virus vaccine.

This report is an evaluation of the efficacy of measles vaccine in a recent measles epidemic which occurred in Texarkana, a city bisected by the Texas-Arkansas state line. More than 95% of the cases were found on the

Texas side of the line, where only 57% of children aged 1 to 9 years had been vaccinated. There was almost no spread of disease into Arkansas, where more than 95% of children had received measles vaccine.

## Locality and Population

Texarkana is a city of 50,000 which is bisected by the Texas-Arkansas state line. Texarkana, Tex, is the major city in Bowie County with a population of 59,971 (according to the 1960 census; detailed 1970 census data are not yet available for Texarkana, but preliminary reports indicate that the population has been stable since 1960). In Bowie County in 1960 there were 11,185 children from 1 to 9 years old. Texarkana, Ark, is the principal unit in Miller County with a population of 31,686, and in that county there were 6,016 children aged 1 to 9 years.

Although the two counties are separated by the state line, they form a single unit socially and economically

and are similar in population structure. People from both counties patronize local business establishments, including stores, a photographer's studio, restaurants, and the town's only indoor movie theater. Most Texarkana churches, as well as parochial and private schools, are attended about equally by people from both states. Other common meeting places include physicians' offices and social events. The two sides of Texarkana do, however, have separate public school systems and separate public health departments.

## Methods of Study

Data on the number of cases of measles reported in previous years were obtained from the records of the Bowie and Miller county health departments.

Measles cases in this outbreak were found by searching health department records and school and nursery records, by asking physicians, by surveying 100 families door-to-door, and by asking families of patients for names of other patients.

Prior immunization levels in Bowie and Miller counties were estimated from vaccine-purchase data provided by the health departments and by private physicians. Vaccine efficacy was calculated by the formula:

$$\% = \frac{\text{Rate of measles for unvaccinated} - \text{minus rate for vaccinated}}{\text{Rate for unvaccinated}} \times 100$$

## Prior Vaccination Status and Incidence of Measles

Before this outbreak, the percentage of vaccinated children in

From the Health Services and Mental Health Administration, Center for Disease Control, Atlanta.

Reprint requests to Immunization Branch, Center for Disease Control, 1600 Clifton Rd, Atlanta 30333 (Dr. Landrigan).

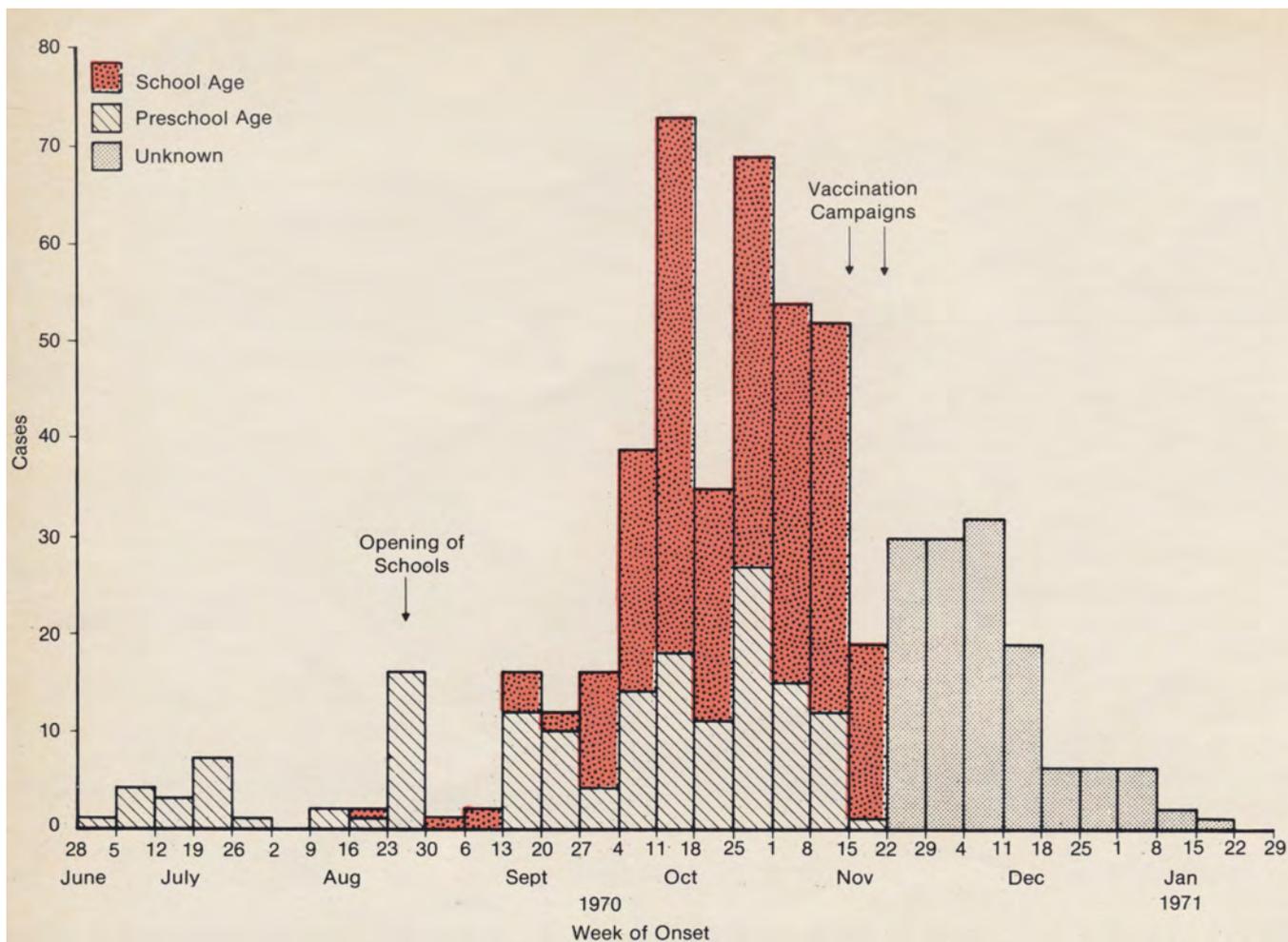


Fig 1.—Measles cases by week of onset; Texarkana, Tex-Ark, June 28, 1970 to Jan 29, 1971.

Bowie County was significantly lower than in Miller County. In Bowie County there had never been a mass immunization campaign against measles, and only 18.8% of children aged 1 to 9 years had received vaccine from the county health department. There was no legal requirement in Texas for measles vaccination in children entering school. The total level of measles immunity from vaccination or history of disease in children aged 1 to 9 years in Bowie County was estimated to be 57%.

In Miller County a state requirement did exist for measles immunization in all schoolchildren, and mass measles vaccine programs had been conducted for school and preschool children in 1968 and 1969; 70.5% of children aged 1 to 9 years had received vaccine from the Miller County Health Department. The total level of immunity, natural plus vaccine-induced, in Miller County was calculated to be more than 95%.

Reports of measles outbreaks in

Texarkana for previous years were somewhat incomplete, but there was no evidence for a major outbreak since 1967. In Miller County, 267 cases of measles had been reported in 1967; these were the only cases reported since 1963. In Bowie County, between 50 and 70 cases were reported in each year from 1963 through 1967 except in 1964, when 365 cases were noted. Only four cases had been reported since 1967.

### The Outbreak

Six hundred thirty-three cases of measles were reported in Texarkana in the seven months from June 1970 through January 1971. There were no fatalities and no cases of encephalitis. The diagnosis of the illness was clinically compatible with measles. Dates of onset of illness were accurately determined for 535 cases. The epidemic curve (Fig 1) shows that small numbers of cases occurred nearly every week during the summer months and that a sharp increase began in early

October, about five weeks after the opening of school. Peak incidence occurred during the weeks of Oct 11 and 25. A gradual decline in the number of cases became evident after Oct 25, but cases continued to occur in small numbers until early 1971.

It was evident from the beginning of this outbreak that almost all of the cases were in Texas. Six hundred six cases (95.7%) were reported from Bowie County and 27 (4.3%) from Miller County (Fig 2). In Bowie County the measles attack rate was 48.2 cases per thousand (Table 1). Cases tended to occur in clusters in schools, day-care centers, and church nurseries; 14 of 15 such clusters were in Texas.

The first known case occurred on June 28 in a 5-year-old boy who attended a public day-care center in Texas. This child had been visiting in Watson, Okla, two weeks before the onset of his illness, but he had had no known exposure to measles. Subsequent spread in the summer was

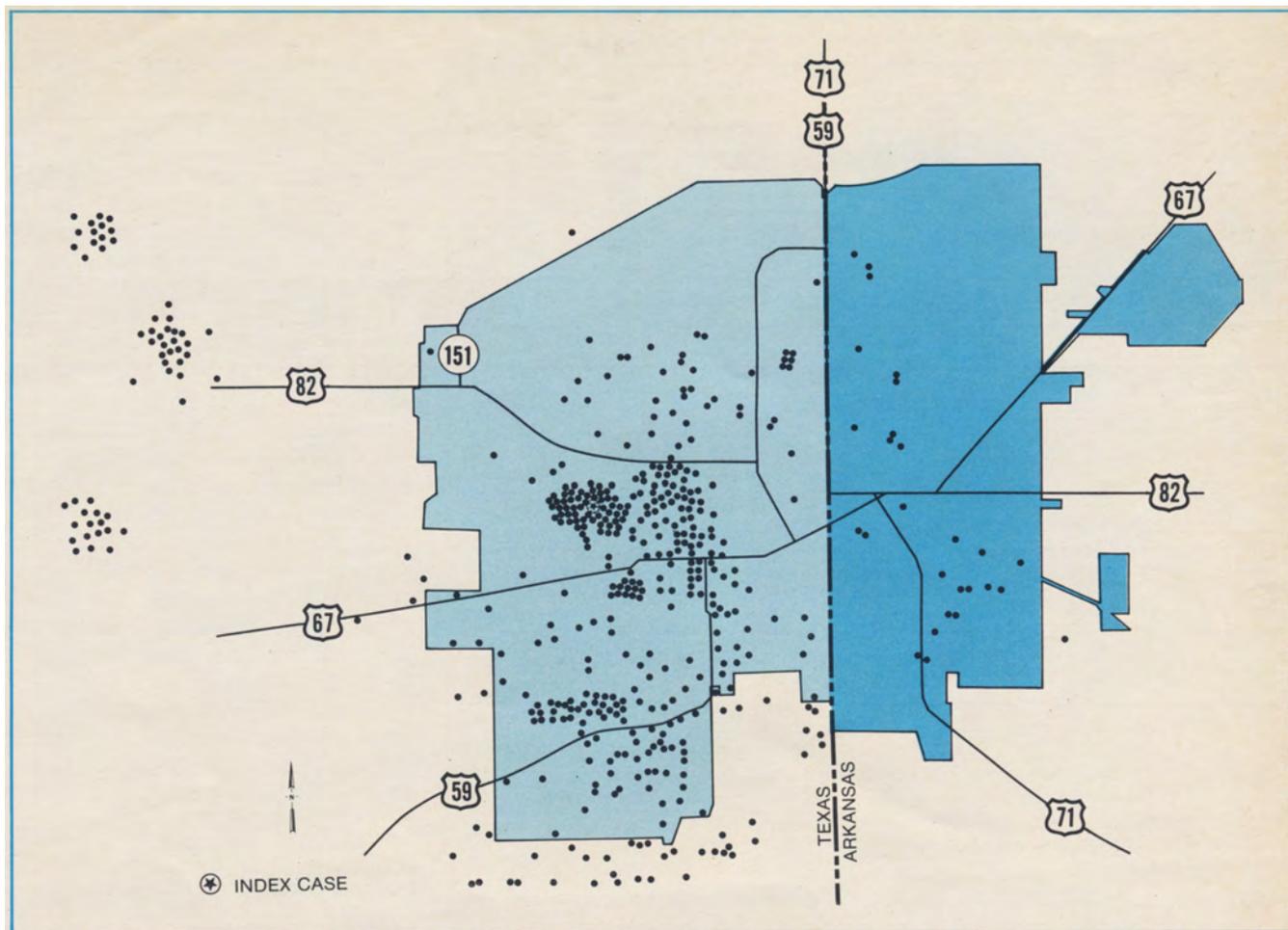


Fig 2.—Cases of measles, Texarkana, Tex-Ark, June 1970 to January 1971.

noted largely among preschoolers, particularly those from poor families in urban Texarkana. Baby-sitters, day-care centers, including the one attended by the index case, and occasionally church groups were involved in this spread. In Bowie County the attack rate for preschool children (age 1 to 4) was 43.8 cases per thousand (Table 1).

Measles also spread among schoolchildren. The attack rate for children age 5 to 9 in Bowie County was 51.7 cases per thousand (Table 1). In the schools, attack rates were highest for children in kindergarten and first grade (Table 2).

In urban Texarkana 73% of cases occurred in preschool children. On the other hand, spread through the schools predominated in suburban and rural areas of Bowie County, where 79% of cases occurred in school-age children.

#### The Arkansas Cases

Twenty-three of the 27 cases in Ar-

kansas were investigated with the same techniques that were used in Texas. In 19 cases there was a definite history of exposure to measles patients from Texas. Sixteen were exposed to Texas children at day-care centers, two were exposed to relatives in Texas with measles, and one had sat beside a child with a "measley" rash in a Bowie County photographer's studio.

#### Measles in Previously Vaccinated Children

In this outbreak, 27 children with measles gave a history of prior inoculation with live, attenuated, measles virus vaccine. In each case the parental history of vaccination was corroborated by clinic or physician records. Six of these patients were found to have received vaccine with immune serum globulin when they were less than 1 year old.

For previously inoculated children, aged 1 to 9, the measles attack rate was 4.3/1,000 (Table 3); the compa-

table rate for unvaccinated children was 105.9/1,000. Based on these data, the vaccine efficacy was 95.9%. However, if we subtract the children who received vaccine with immune serum globulin as infants, the efficacy rate is 96.9%.

#### Immunization Program

In November 1970, measles immunization clinics were conducted in Bowie County. Two clinics were held on a Sunday in community centers in low-income areas of Texarkana, and 12 were conducted on a weekday in schools throughout the county. An effort was made to enroll preschool children in all of these clinics. A total of 2,330 children, an estimated 53% of the susceptibles in Bowie County, received vaccine through these programs. While total immunization levels were raised to 81% by the campaign, the results were uneven. Response was poorest in urban Texarkana and among preschool children in rural areas.

Age, yr	Miller County			Bowie County		
	Population	No. of Cases	Attack Rate (per 1,000)	Population	No. of Cases	Attack Rate (per 1,000)
1-4	2,671	19	7.1	4,933	216	43.8
5-9	3,345	6	1.8	6,252	323	51.7
<b>Total</b>	<b>6,016</b>	<b>25</b>	<b>4.2</b>	<b>11,185</b>	<b>539</b>	<b>48.2</b>

\*Bowie County, Texas, and Miller County, Arkansas, June 1970 to January 1971.

Grade	No. of Cases	No. of Pupils	Attack Rate (per 1,000)
Public kindergarten	27	120	150.0
1	72	805	89.4
2	35	743	47.1
3	33	624	52.9
4	34	538	63.2
5	11	381	28.9
6	9	363	24.8

\*Bowie County, Texas, June 1970 to January 1971. Based on school enrollment data from school with measles outbreaks; not based on census data.

	No. of Children	No. of Cases	Attack Rate (per 1,000)
Immunized	6,350	27	4.3
Unimmunized	4,835	512	105.9
<b>Total</b>	<b>11,185</b>	<b>539</b>	<b>48.2</b>

\*Bowie County, Texas, June 1970 to January 1971.

The shape of the epidemic curve was not greatly altered by the vaccine campaign (Fig 1). It was noted, however, that after the campaign, measles did not spread into any previously unaffected school districts.

### Comment

The major point illustrated by this outbreak is that measles vaccine protected children against measles. The spread of measles in this epidemic did not result from vaccine failure, but from inadequate use of vaccine. In Texas, where only 57% of children aged 1 to 9 years had received vaccine, a major epidemic with an attack rate of 48.2 cases per thousand occurred. In Arkansas, where immunization levels were much higher, there was no epidemic.

In this epidemic measles spread among both preschoolers and school-children. Preschool spread predominated in urban Texarkana, while school-age spread was seen principally in the suburban and rural areas. The common factor in both areas was, however, that disease spread in unvaccinated children grouped together for the first time. Thus, in the city, at-

tack rates were high for preschool children who came together in day-care centers and nursery schools. In the rural areas, measles spread among older children, who mingled for the first time when attending public schools. Urban spread in Texarkana resembles the pattern in the 1967 to 1968 Chicago measles epidemic,<sup>3</sup> while the rural pattern is similar to that more traditionally described in the United States.<sup>4</sup>

In this outbreak, measles vaccine efficacy was calculated to be approximately 96%. This result confirms other epidemiologic reports of the effectiveness of measles vaccine in preventing measles.<sup>5,6</sup> These data also corroborate serologic investigations on the persistence of vaccine-induced measles antibody.<sup>7,8</sup>

Twenty-seven children who had been previously vaccinated against measles contracted the illness in Texarkana. Vaccine failures usually stem from one of three sources: (1) Vaccination with measles immune globulin before age 1<sup>9,10</sup>; six such children were seen in this outbreak. Many of these were vaccinated between June 1963 and February 1965, when it was rec-

ommended that Edmonston strain measles vaccine be administered at 9 months of age with immune serum globulin to reduce febrile side effects of the vaccine.<sup>11,12</sup> (2) The failure to protect vaccine from exposure to heat and light<sup>13</sup>; no such cases could be documented in this outbreak; and (3) The failure to seroconvert after vaccination,<sup>14</sup> the other 21 cases of vaccine failure appear, by exclusion, to have stemmed from failure to seroconvert.

The difficulties in vaccine delivery encountered in Texarkana resemble those seen in many areas of the United States, particularly among low-income groups. The 1970 US Immunization Survey indicates that only 40.7% of children aged 1 to 13 years in urban poverty areas have received measles vaccine, while more than 54% of children in "nonpoverty" metropolitan areas have been vaccinated. The experience in Arkansas indicates, however, that a community immunization campaign can deliver sufficient vaccine to all segments of a population to prevent an epidemic.

### References

1. Reported incidence of notifiable disease in the United States, 1969. Annual summary, 1969. *Morbidity Mortality Weekly Rep* 19:4, 1970.
2. Measles—United States, 1970-71. *Morbidity Mortality Weekly Rep* 20:239, 1971.
3. Hardy GE Jr, Kassanoff I, Orbach HG, et al: The failure of a school immunization campaign to terminate an urban epidemic of measles. *Amer J Epidemiol* 91:286-293, 1970.
4. Nader PR, Sills JR, Calafiore D, et al: Measles epidemic control in Mason County, Kentucky, 1965 to 1966. *JAMA* 200:811-814, 1967.
5. Measles in previously immunized children. *Morbidity Mortality Weekly Rep* 18:141-142, 1969.
6. Wyll SA, Witte JJ: Measles in previously vaccinated children, an epidemiologic study. *JAMA* 216:1306-1310, 1971.
7. Krugman S: Present status of measles and rubella immunization in the United States: A medical progress report. *J Pediatr* 78:1-16, 1971.
8. Lepow ML, Nankervis GA: Eight-year serologic evaluation of Edmonston live measles vaccine. *J Pediatr* 75:407-411, 1969.
9. Baratta RO, Ginter MC, Price MA, et al: Measles (rubeola) in previously immunized children. *Pediatrics* 46:397-402, 1970.
10. Measles—Alabama. *Morbidity Mortality Weekly Rep* 20:115-116, 1971.
11. Statement on the status of measles vaccines, Ad hoc advisory committee on measles control. *JAMA* 183:1112-1113, 1963.
12. Measles vaccine: Status and recommendations for use. *Morbidity Mortality Weekly Rep* 14:64-66, 1965.
13. Lerman SJ, Gold E: Measles in children previously vaccinated against measles. *JAMA* 216:1311-1314, 1971.
14. Katz SL, Kempe CH, Black FL, et al: Studies on an attenuated measles-virus vaccine: VIII. General summary and evaluation of the results of vaccination. *New Eng J Med* 263:180-184, 1960.