

# Measles Epidemiology and Vaccine Use in Los Angeles County, 1963 and 1966

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**M**EASLES has been the classic childhood illness in the United States, accepted by parents as an inevitable occurrence, along with wornout shoes and knee abrasions. Seldom has the general public recognized the complications of measles—encephalitis, pneumonia, otitis media, and neurological changes detectable only on electroencephalograms. Therefore, the vaccines for measles were not greeted with the same overwhelming demand as were the poliomyelitis vaccines. Even physicians have needed urging to adopt measles immunization as a routine in their practices (1).

The first vaccine for protection against measles was licensed in March 1963. In Los Angeles County, this and subsequent vaccines were used only in private practice until July 1, 1965, when the county health department obtained funds to immunize infants in the well-baby clinics. Not until April 1966, when a measles epidemic threatened the county, was measles vaccine used communitywide in Los Angeles County. The effect of this mass measles immunization will be analyzed in a separate paper.

My study was undertaken to determine if use

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of measles vaccine in Los Angeles County had altered the epidemiologic characteristics of the disease. A second purpose was to determine the current pattern of measles infection in the county so that future immunization efforts could be effectively planned.

## Method

Data on measles cases reported to the County of Los Angeles Department of Health in the first 26 weeks of 1963 and of 1966 were selected for study. Analysis was limited to the first 26 weeks of 1966 in order to include the most recent data. This period includes the peak measles season in Los Angeles: in high incidence years, 84 to 94 percent of the recorded measles cases are reported in the first 6 months of the year. I selected the year 1963 for comparison because it represented the last measles season in which the population was not protected by vaccine. Both years represented peaks in the cyclical distribution of measles in the county.

In 1963, there were five health departments in Los Angeles County. The cities of Los Angeles, Long Beach, Pasadena, and Vernon each had a separate health department; in the remainder of the county, public health was the responsibility of the County of Los Angeles Department of Health. On July 1, 1964, the Los Angeles City Department of Health was merged with the county department. For 1963, individual data on reported measles cases were readily available for analysis from the juris-

diction of the county health department; in 1966, data were available from the combined Los Angeles city and county departments.

For individual cases of measles the following data are reported to the health department on confidential morbidity report cards: name, address, age, sex, and race of the patient and dates of onset and of diagnosis of the disease. The department codes this information into the categories of age, sex, health district of residence, and ethnic group on the basis of race or surname and date of the report. Because of the large Mexican-American population in the county, persons with Spanish surnames are coded separately from the remainder of the white race.

Information on the distribution of measles vaccines in the county was obtained from representatives of the pharmaceutical companies which by June 1966 had been licensed to distribute measles vaccines.

### Results

The number of reported cases of measles and incidence rates for the first 26 weeks of 1963 and of 1966 are presented in table 1 by health department jurisdictions. For my study, data were available for 4,685 reported cases from 1963 and for 5,427 cases from 1966. The case rate in the different health department areas was more uniform in 1966 than in 1963, when the city of Los Angeles reported only half as many measles

**Table 1. Cases of measles reported in Los Angeles County and rates per 100,000 population, by health department jurisdiction, weeks 1-26 of 1963 and 1966**

Health department area	1963		1966	
	Cases	Rate	Cases	Rate
Vernon, Long Beach, and Pasadena.....	585	123	468	94
City of Los Angeles <sup>1</sup> .....	1,620	62	<b>2,252</b>	98
Remainder of Los Angeles County.....	<b>4,685</b>	128	<b>3,175</b>	77
Total.....	6,890	109	5,895	85

<sup>1</sup> Separate health jurisdiction in 1963; combined with County of Los Angeles Department of Health in 1964.

NOTE: Numbers in boldface type represent cases analyzed in the study.

**Table 2. Reported measles cases per 100,000 population, by health district, Los Angeles County, weeks 1-26 of 1963 and 1966**

Health district	1963	1966
Health jurisdiction of City of Los Angeles		
Angeles.....	62	98
Central.....	78	99
East Valley.....	51	22
Harbor.....	60	175
Hollywood.....	59	44
Northeast.....	62	139
South.....	93	373
Southeast.....	82	190
Southwest.....	82	136
West <sup>1</sup> .....	57	-----
West Valley.....	43	16
Health jurisdiction of Los Angeles County		
Alhambra.....	143	39
Bellflower.....	77	50
Compton.....	149	163
East Los Angeles.....	112	154
El Monte.....	111	105
Glendale.....	64	26
Inglewood <sup>1</sup> .....	88	89
Monrovia.....	249	36
Pomona.....	207	148
San Antonio.....	164	89
San Fernando.....	77	61
Santa Monica <sup>1</sup> .....	290	72
Torrance.....	95	45
Whittier.....	136	58

<sup>1</sup> In 1966, the West Health District was divided between the Inglewood and Santa Monica districts.

cases per 100,000 population as the other health departments in the county.

*Week of report.* The seasonal distribution of reported measles cases is apparent in figure 1. In 1963, the peak in reported cases occurred in the 20th week; in 1966 the peak was in the 17th week. The number of reported cases declined more rapidly after the peak in 1966 than after the one in 1963. A mass measles immunization program in the county was carried out in the 16th and 17th weeks of 1966.

Eighty-nine percent of the total measles case reports in 1963 were received in the first 26 weeks; 94 percent of the 1966 case reports were received in the first half of the year.

*Health districts.* In 1963, there were 24 health districts in Los Angeles County—10 under the Los Angeles City Department of Health and 14 under the county health department. At present the merged county health department is divided into 23 health districts on the basis of topography, city boundaries, and the need for public health services. The districts vary in

population from 100,000 to 450,000 and in the economic, ethnic, and age characteristics of the inhabitants.

The incidence of reported measles cases in each district is presented in table 2. In 1963, the rates in the districts of the city of Los Angeles were very similar; in 1966, however, they ranged from 16 per 100,000 in the West San Fernando Valley Health District to 373 per 100,000 in the South (Watts) Health District. The rates in the city have decreased in the middle and upper socioeconomic areas and have increased in areas with large populations of the lower socioeconomic group. For both years, there was marked variation in rates between the districts of Los Angeles County. In 1966, however, the rates increased only in the two districts of Compton and East Los Angeles, where the populations are predominately of the lower socioeconomic group.

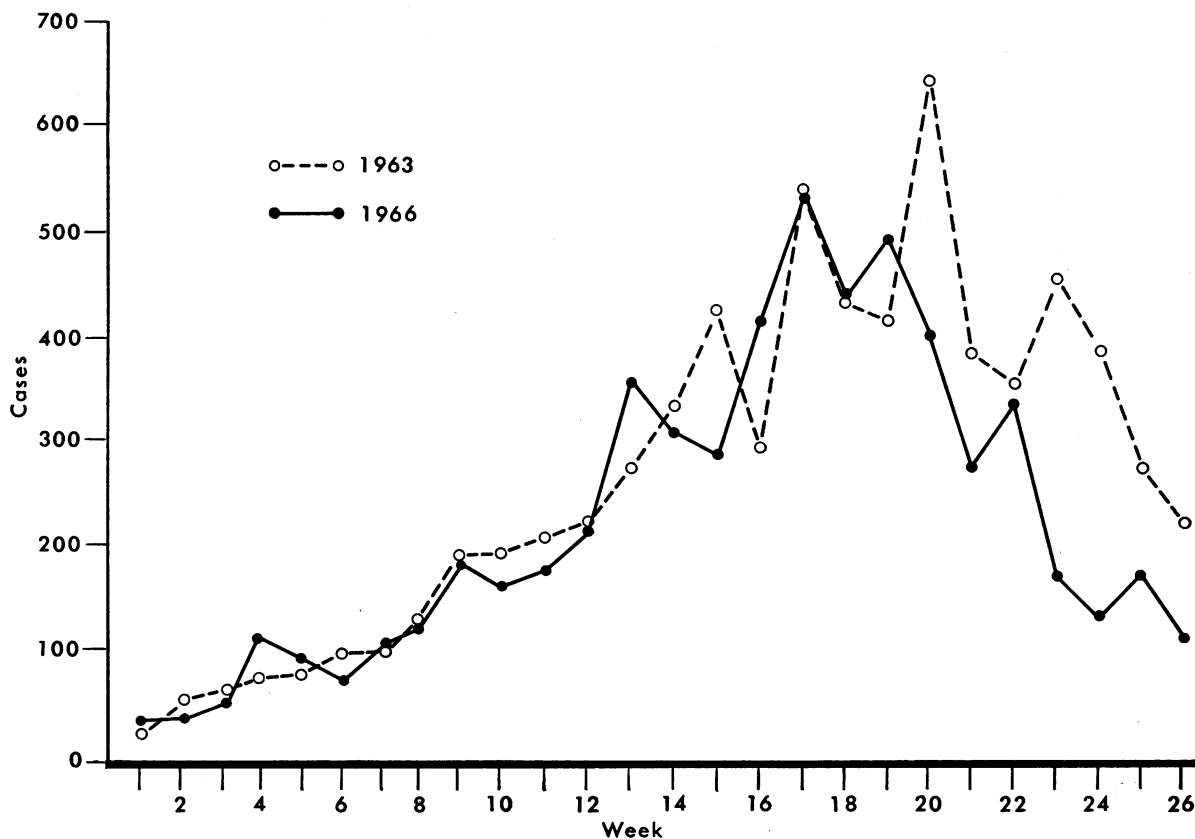
*Sex.* In 1966, two county health districts reported considerably more cases of measles in females: the South Health District had 305

cases in females compared with 244 in males, and the Southeast Health District had 129 cases in females and 95 in males. These two districts have the highest percentage of Negroes of any districts in the County of Los Angeles Department of Health. Data on sex distribution of measles cases for these districts was not available for 1963.

In general, health districts with a higher socioeconomic level reported more cases in males; the lower socioeconomic districts reported more cases in females. There was no significant difference for either year in the sex distribution of cases by ethnic group, either for the health jurisdiction of the county or of the city of Los Angeles.

*Ethnic group.* The distribution of reported measles cases by ethnic group was compared with the ethnic distribution of the total population (table 3). The white population with Spanish surnames was predominately Mexican-American. The "Other nonwhite" classification in the study included Chinese, Japanese, Fili-

**Figure 1. Reported cases of measles, Los Angeles County, weeks 1-26 of 1963 and 1966**



pino, American Indian, and other unspecified nonwhites. The three Oriental groups comprised 90 percent of the "Other nonwhite" classification in 1963, 80 percent in 1966.

In 1963, measles was reported in the ethnic groups in direct relation to their proportion in the total population. In 1966, however, the percent of cases in Negroes and persons with Spanish surnames was much higher than the percent of the total population represented by these two groups. A marked increase in the proportion of cases in Negroes and persons with Spanish surnames was apparent for almost every district.

The mean week of report for cases of measles was significantly earlier in both years for cases

reported in white persons, other than those with Spanish surnames, than for cases reported in Negroes ( $P=0.01$ , according to  $t$  test), as the following data show:

Ethnic group	Mean week of report	
	1963	1966
White, with Spanish surname.....	17.9	16.0
Other white.....	17.0	15.8
Negro.....	18.2	16.8
Other nonwhite.....	16.9	16.1
Total.....	17.1	16.1

*Age.* Distribution of the reported measles cases by age group of patient shows an increased percent in 1966 among those in the preschool age group as compared with earlier years (table 4). (The only previous year for which the per-

**Table 3. Percent of reported measles cases and percent of total population of ethnic groups, by health department jurisdiction, Los Angeles County, weeks 1-26 of 1963 and 1966**

Ethnic group	Los Angeles County			City of Los Angeles		Both jurisdictions	
	Percent of cases		Percent of 1960 population <sup>1</sup>	Percent of 1966 cases	Percent of 1960 population <sup>1</sup>	Percent of 1966 cases	Percent of 1960 population <sup>1</sup>
	1963	1966					
White with Spanish surname.....	9.1	21.3	10.3	19.3	10.4	20.4	9.0
Other white.....	86.6	63.4	85.4	23.8	72.8	47.0	81.3
Negro.....	2.9	12.4	3.3	51.2	13.5	28.5	7.7
Other nonwhite.....	1.4	1.6	1.0	1.6	3.3	1.6	2.0
Not stated or unknown.....		1.4		4.2		2.5	

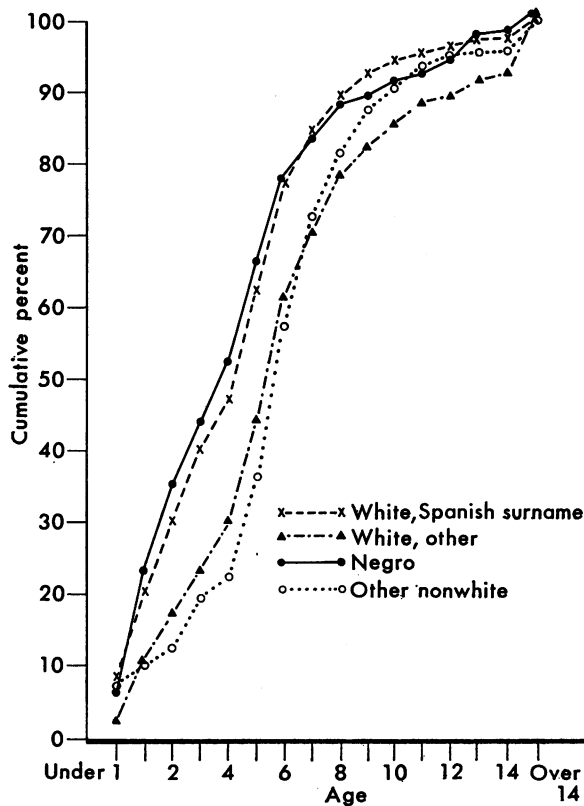
<sup>1</sup> Source of 1960 data: Health departments of Los Angeles County, Pasadena, Vernon, and Long Beach: Social and economic characteristics from the 1960 census. School of Public Health, University of California, Los Angeles, July 1963, p. 5.

**Table 4. Percent distribution of reported measles cases, by patient's age group and by health department jurisdiction, Los Angeles County, year 1960 and weeks 1-26 of 1963 and 1966**

Age group (years)	Percent of total cases for period				
	Los Angeles County		City of Los Angeles		Both jurisdictions
	1963	1966	1960 <sup>1</sup>	1966	1966
Less than 1.....	1.9	4.0	4.7	7.4	5.3
1-4.....	19.9	28.9	39.7	43.8	35.4
5-9.....	65.5	53.4	46.1	36.8	46.3
10-14.....	10.1	7.9	5.7	8.4	8.0
15 and over.....	2.6	5.8	3.8	3.6	5.0

<sup>1</sup> Only previous year for which percent distribution by age was available. Source of 1960 data: Observations of disease periodicity and trends. Division of Epidemiology, School of Public Health, University of California, Los Angeles (unpublished).

**Figure 2. Cumulative percent of reported measles cases for four ethnic groups, by age of patient, Los Angeles County, weeks 1-26 of 1966**



cent distribution by age was available for the city of Los Angeles was 1960.) The ages of patients ranged from less than 3 months to more than 60 years in both 1963 and 1966.

The distribution of reported cases by age differed significantly ( $P=0.01$ —chi-square for independence, 9 degrees of freedom) for the four ethnic groups (fig. 2). The mean age of patients with reported cases in 1966 was 4.7 years for the Negro group, 4.8 years for those with Spanish surname, 6.4 years for the other nonwhite group, and 7.0 years for the other white group.

The mean age of the patients with reported cases increased week by week in 1966, particularly after the 16th week, when the mass immunization campaign took place (fig. 3). A similar rise in mean age was not noted in 1963.

Of particular interest were cases of measles reported in children under 1 year of age, since such children supposedly receive passive immunization from maternal antibodies. Cases in this

age group accounted for 2 percent of the total cases studied in 1963 and 5 percent of the total studied in 1966, as indicated in table 5. The largest number in infants both years was reported in children in the age group of 7 to 9 months. In 1966, almost 70 percent of the cases in infants were in Negroes and those with Spanish surnames.

*Vaccine distribution.* Estimates of the quantity of measles vaccine distributed in the county (table 6) were based upon vaccine purchases, not on actual doses given. In 1963 only inactivated vaccine (A) and the Edmonston strain of live, attenuated vaccine (B) were available. Currently, most measles vaccine used in Los Angeles County is of the Schwarz strain (C). Of the 226,000 doses of this vaccine distributed in the county during the first 6 months of 1966, the county health department gave 96,000 doses.

## Discussion

Measles cases have always been under-reported. Dr. David J. Sencer, chief of the National Communicable Disease Center, Public Health Service, has estimated that reported

**Table 5. Reported measles cases among infants under 1 year of age, by 3-month age groups and by ethnic group, Los Angeles County, weeks 1-26 of 1963 and 1966**

Age and ethnic group	1963 cases— Los Angeles County health jurisdiction		1966 cases— Los Angeles County and city health jurisdictions	
	Num- ber	Per- cent	Num- ber	Per- cent
Total.....	90	100	284	100
Age groups (months):				
1-3.....	9	10	9	3
4-6.....	20	22	54	19
7-9.....	38	42	133	47
10-12.....	23	26	88	31
Ethnic groups:				
White with Spanish surnames.....	28	31	94	33
Other white.....	53	59	71	25
Negro.....	9	10	102	36
Other nonwhite.....	0	-----	6	2
Not stated or unknown.....	0	-----	11	4

measles cases represent only 10 percent of the actual number (2). If reporting remains consistent, it may be assumed that the percent of cases reported is approximately the same each year and that trends in incidence over the years can be determined. When different geographic areas are compared, however, incomplete reporting of a disease may cause serious difficulties since the proportions reported may differ markedly in different regions. For 8 of the 10 years 1955-64, the reported measles rate for the city of Los Angeles was approximately half the rate for the remainder of the county. In contiguous urban areas, it is unlikely that there could have been twice as many cases of measles in one area as in another. Differences in reporting practices must account for the variation in rates.

Upon the advent of measles vaccines, the medical profession and the general public looked for a decrease in measles incidence. Increased awareness of the disease, however, may have resulted in increased reporting of cases. Therefore, case rates reported for 1966 may have been higher than expected because previ-

**Table 6. Estimated doses of measles vaccines distributed in Los Angeles County, by type of vaccine, 1963-66**

Type of vaccine	1963 <sup>1</sup>	1964	1965	1966 <sup>2</sup>
Inactivated-----	47,000	28,000	16,500	9,000
Live, attenuated (Edmonston strain)-----	125,500	131,000	86,000	59,500
Live, attenuated (Schwarz strain)-----			57,000	226,000

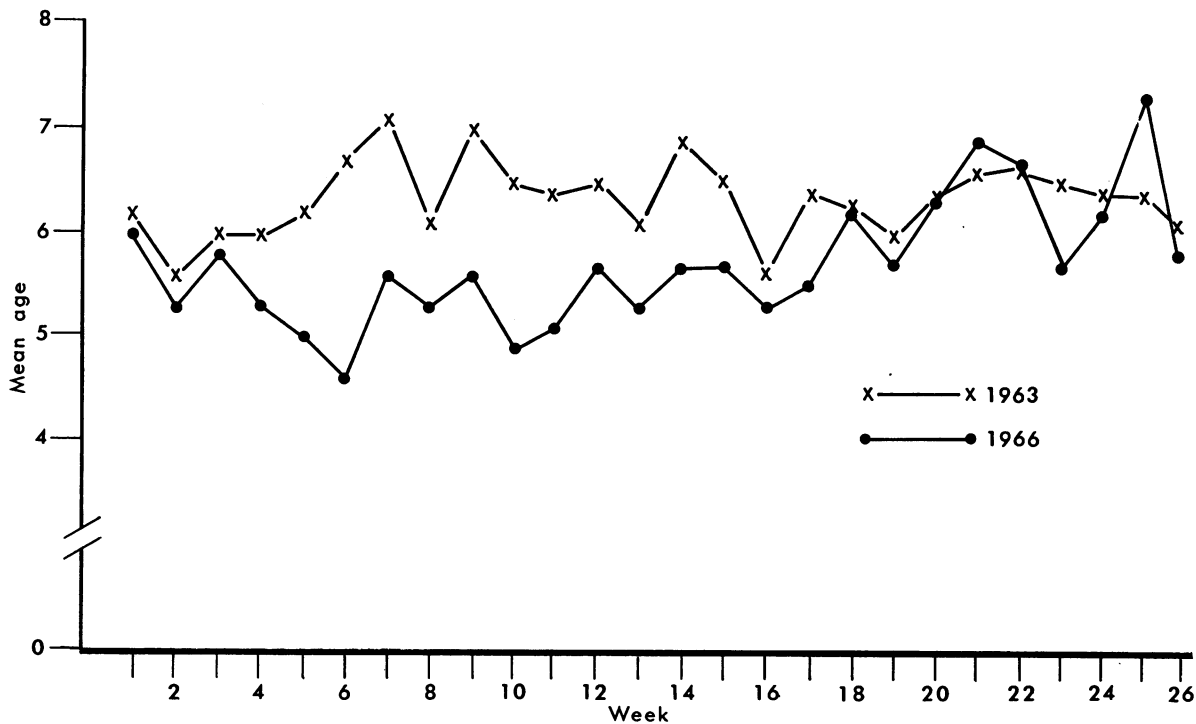
<sup>1</sup> March 23 through December 31.

<sup>2</sup> January 1 through June 30.

ous reporting practices may not have been maintained.

*Week of report.* The rapid decline in 1966 in the numbers of reported cases of measles after a peak in the 17th week probably represents the effect of the mass immunization program. In the 16th and 17th weeks of 1966, more than 87,000 doses of measles vaccine were administered in health department clinics. Sixty-six percent of this vaccine was given to

**Figure 3. Mean age of patients with reported measles cases, Los Angeles County, weeks 1-26 of 1963 and 1966**



children under 6 years of age. This rapid immunization of preschoolers could explain the rising mean age of the persons with reported measles cases after the 16th week (fig. 3).

*Sex.* Differences in sex distribution of measles cases in a few health districts and the suggested relationship in some districts between the sex of patients and their socioeconomic level are interesting; no explanation is apparent at present.

*Ethnic group.* In 1966, measles became, in Los Angeles County, a disease of the Negro population and the population with Spanish surnames. Although these two groups accounted for only about 17 percent of the county population, 49 percent of the reported cases were in these groups. This change in the distribution of measles cases was inversely related to the pattern of utilization of measles vaccine. Before 1966, the vaccines were used almost exclusively by private physicians. Thus, the districts which had many physicians and a population able to afford private care had high percentages of immunized children by 1966. The lowest rate of reported measles cases in the entire county was for the suburban health districts of the East and of the West San Fernando Valley, where young middle- and upper-class white families predominate. In the South (Watts) Health District, where the population is largely Negro and of the lower socioeconomic class and where private physicians are lacking, the rate of reported measles was the highest.

The countywide changes in the ethnic distribution of measles cases resulted not only from the very high rates in districts principally comprised of Negroes and of persons with Spanish surnames. Cases among Negroes and persons with Spanish surnames increased in all districts of the county. As noted, the peak week in both 1963 and 1966 for reported measles cases was later for Negroes than for other ethnic groups. Possibly, the cases in Negroes were diagnosed or reported later in the course of illness or were reported in retrospect after multiple cases in a family had occurred.

*Age.* The shift in 1966 to higher percents of reported cases among the county's Negro population and the population with Spanish surnames was accompanied by a shift in distribution to younger age groups. Cases among

preschool children accounted for a larger percent of the total cases reported in 1966 than in 1963. The curves of cumulative frequency of reported cases by age of patient (fig. 3) are similar to the curves by age for persons with a past history of measles reported by Langmuir (3).

Since measles immunization has been directed principally toward the preschool child over 12 months of age, a decrease in the percent of cases in this age group would be expected. Apparently this decrease did not occur because of the large number of cases in unimmunized preschoolers from Negro families and families with Spanish surnames. Improved reporting may also have accounted for the increase in cases among younger children. Langmuir (3) has shown that the true peak of measles incidence falls in the age group 3 to 4 years, while for reported cases the peak is usually at the 6th year. In the Los Angeles County study, based on reported cases, the peak was at 6 years, both in 1963 and 1966.

From the curves in figure 2 it appears that in Los Angeles County in 1966 Negro children and those with Spanish surnames were infected with measles earlier in life than were other white and other nonwhite children. Since fewer preventive and curative medical services may be available to the Negro children and those with Spanish surnames, one would expect proportionately fewer preschool cases to be reported in these groups. The services which these groups use most frequently, however, namely, health department and county hospital clinics, have very complete reporting procedures. Thus, it is difficult to determine whether the age differences are due to reporting differences between ethnic groups. Larger families, resulting in greater spread of measles from school children to preschoolers in Negro families and those with Spanish surnames, also could account for this difference in age distribution of cases among various ethnic groups.

The number of reported measles cases in infants was highest in the 7- to 9-month-old group both in 1963 and 1966. Since most of these cases occurred in Negro children and children with Spanish surnames, it is unlikely that use of measles vaccine accounted for the decrease in cases in the 10- to 12-month-old group. Since live, attenuated measles vaccine is now recom-

mended only for children 1 year and older, cases may be expected among infants unless the older siblings who serve as the source of infection are immunized. Until high rates of measles immunization are achieved, passive immunization of infants with gamma globulin following known measles contact may be necessary.

In Los Angeles County there are about 1.5 million children under 10 years of age. About 400,000 children in the county had been adequately immunized against measles before 1966. Another 400,000 in the 5- to 9-year-old group were already immune as a result of measles infection. Dr. Robert J. Warren of the National Communicable Disease Center, Public Health Service, has estimated that "reduction of U.S. susceptibles by 40 percent probably would be enough for measles eradication, if the vaccine had been used homogeneously over the entire population" (2). Los Angeles had come close to this 40 percent level before 1966; vaccine utilization, however, had been concentrated in the white population who received medical services from private physicians.

Godfrey (4) reported in 1932 that, in order to decrease diphtheria incidence in a community, it was necessary to immunize 30 percent of the children under 5 years old in addition to more than 50 percent of the children 5 to 9. Immunization of 70 percent of school children only was not effective in reducing diphtheria. Thus, it has been demonstrated that the preschool child is the key to prevention of the spread of diphtheria and measles. Increased attention in Los Angeles needs to be directed to measles immunization of the children under 5 years among Negro families and families with Spanish surnames.

When the immunization level is sufficiently high to produce a significant decrease in the incidence of measles, large numbers of unimmunized children are protected from infection by lack of contact with an infected person rather than by their own antibodies. These children will remain susceptible to measles until their adult life. Panum (5) demonstrated that all age groups were susceptible in the absence of prior contact with the disease. Even if measles is eradicated in the United States, it will remain endemic for many years in other countries. The

possibility of infection in adult life can be prevented only by immunizing every person in his preschool years or upon entry to any school.

### Summary

To determine if use of measles vaccines had altered the epidemiologic characteristics of measles cases, 4,685 of the reported cases in Los Angeles County for 1963 were compared with 5,427 of the cases for 1966. A mass immunization campaign in April 1966 apparently caused a more rapid decline in the epidemic curve compared with the 1963 curve and also caused an increase in the mean age of patients whose cases were reported subsequently.

In 1966, measles in Los Angeles County became a disease of the Negro population and the population with Spanish surnames; an accompanying increase occurred in the percent of cases among preschool children. In the past, measles vaccines had been distributed unequally in the county, being used primarily by private physicians. If this disease is to be controlled in the United States, measles immunization must be made available to all segments of the population irrespective of their economic status or source of medical care.

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- (5) Panum, P. L.: Observations made during the epidemic of measles on the Faroe Islands in the year 1846. American Public Health Association, New York, reprinted 1940.

### SUPPLY REFERENCES

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- (B) Measles virus vaccine, live, attenuated (Edmonston strain), Lyovac Rubeovac, Pfizer-Vax Measles-L, M-Vac.
- (C) Measles virus vaccine, live, attenuated (Schwarz strain), Lirugen.