Predictions that measles would be eradicated through vaccination have not been fulfilled. The reasons for this failure are analyzed in this paper, and the possibilities for successful action against measles are outlined.

THE EPIDEMIOLOGIC RATIONALE FOR THE FAILURE TO ERADICATE MEASLES IN THE UNITED STATES

J. L. Conrad, M.D., M.P.H., F.A.P.H.A.; Robert Wallace, M.D.; and John J. Witte, M.D., M.P.H., F.A.P.H.A

FOUR years ago a paper was presented at the American Public Health Association meeting in San Francisco stating that the tools were in hand that would make measles eradication possible in the United States by the end of 1967. The authors also outlined a plan of attack that, if followed, theoretically assured measles eradication.[1] This paper will review that plan and analyze what has actually happened in the last 4 years, for, indeed, today measles is on the increase. Eradication, if possible, now seems far in the future.

Figure 1 presents a graph of cases of measles by 4-week periods for the years 1956–1970. For the years 1956 to 1958, an average of 600,000 cases were reported yearly in the U.S.; from 1959 to 1964, an average of 450,000 cases were reported. Although live measles virus vaccine was first licensed in the U.S. in 1963, relatively little vaccine was distributed until 1965, when the Federal Vaccination Assistance Act was amended to include measles vaccine. Nineteen sixty-five and 1966 were record low years of approximately 250,000 measles cases; at this point, it was felt by many that a national measles eradication program might be possible.

From the many epidemiologic studies of measles it was concluded in the 1966 APHA paper, that any program for measles eradication in the U.S. would have to fulfill four essential conditions:

a) Routine immunization of infants at 1 year of age.

b) Immunization of all remaining susceptible children on entering school or other place of congregation (nursery school).

c) Improved surveillance of the disease at all levels.

d) Prompt epidemic control when outbreaks are first recognized.

Of these four points, the first, routine immunization of all infants at 1 year of age, is the crucial cornerstone of a successful eradication program. Until such time as routine vaccination of 1-year-olds is effectively carried out in all areas of the country, and covers all segments of our population, the other three points must continue to be emphasized. The degree to which we must occupy ourselves with these remaining three points might well serve as an indicator of the degree of failure of our whole program.

Status of Measles from 1966 to 1970

Figure 1 also shows the measles incidence by 4-week periods for the period 1956 to 1970; it shows the degree of effectiveness of the overall attack on measles in the years 1966 to 1969 and the failure since December 1969 to main-

tain the downward trend of the previous 3 years. Figure 2 demonstrates the past 4 years more dramatically by plotting the cases by 4-week periods and by epidemic years since 1966. During this past epidemiologic year,* the resurgence of measles has been a widespread problem all over the U.S.; almost no state has been spared, and every major city has been involved. Table 1 breaks this down further in a state-by-state tabulation. Forty-one states and the District of Columbia had increases in the past year over the previous year; nine states and New York City reported decreases; and one state, Vermont, managed to hold its own. The map, (Figure 3) demonstrates the magnitude of the increases in broad generalities and shows once again the problem extends from coast to coast.

Why? Analysis and Comments

Let us return to the four essential points of the eradication effort and consider how well we have managed on each point and why measles is again on the upswing.

a) Immunization of all infants at age 1. Immunization Assistance Grants to state and local health departments previously covered 48 states and 93 per cent of the U.S. civilian population. These grants had built into them the mechanism to support programs aimed at universal measles immunization at age 1. Each state administered their grant with varying but increasing success regarding this particular point. Various techniques, such as Birth Certificate Follow-Up Programs, were underway and Well Baby Clinic Immunization Programs were beginning to be established. Promotional and educational material had been developed and made available to all grant areas, and liaison with the American Academy of Pediatrics and with state medical societies was beginning. A number of states carried out statewide immunization programs that included preschoolers—you are familiar with all of these. The job remains un-

* 1969 measles epidemiologic year—October 5, 1969 to October 10, 1970.

Figure 1—Reported measles by four-week periods, United States, 1956–1970 (first 40 weeks)

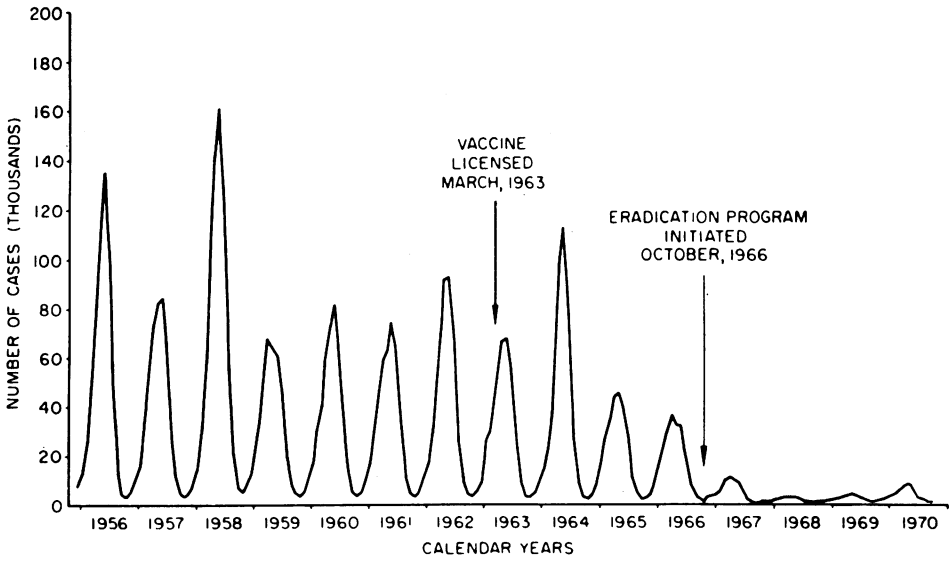
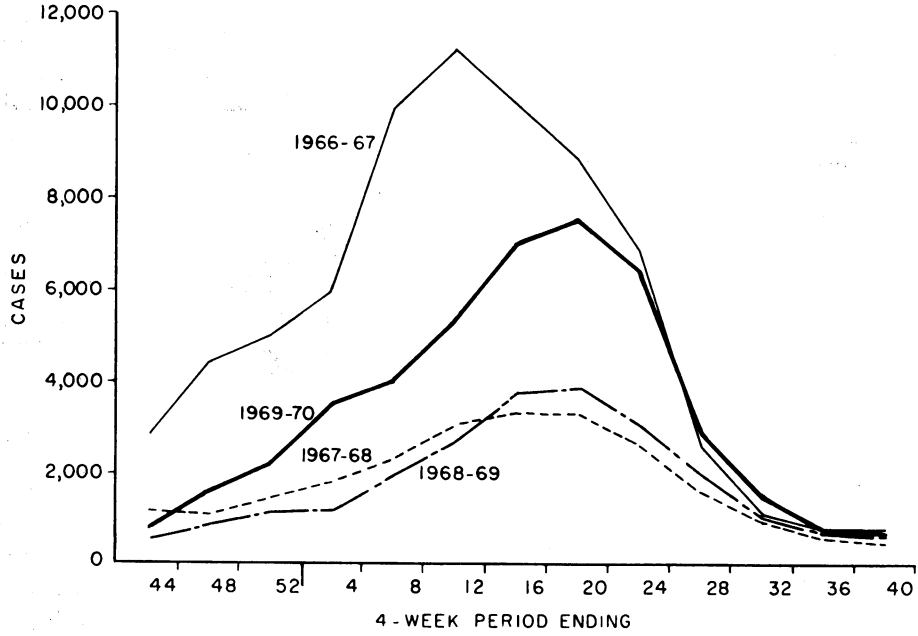


Figure 2—Reported cases of measles by 4-week period, USA, epidemiologic year 1969–70 compared with 1966–67, 1967–68, and 1968–69



finished at the moment, though. A very major reason for the recent increase in measles appears to be that the national interest in rubella control has pushed ahead of interest in measles control. As a result of these changing priorities, this measles program has not been funded at the federal level since July 1969.

b) Immunization on entering school. A recent survey of all Immunization Project Directors by the Center for Disease Control revealed that as of September 1970, 21 out of 53, or only 40 per cent, of the states and territories had a measles immunization requirement for school entry. Until such time as such laws are enacted, it is doubtful that school entrance immunization will be widespread. From the current survey response we can assume that there is not enough local interest now for such legislation. It is of incidental interest to note that 27 out of 53, or 50 per cent, of the states and territories now have laws requiring smallpox vaccination for school entry.

c) Improved surveillance and reporting of measles at all levels. Although improvements in this are very difficult to quantitate, several states or local areas, such as Rhode Island, Los Angeles County, and Maryland, have been successful in investigating all reports of measles in the past year. As a direct result of this, better age specific measles case data are available, and on a wider scale than ever before; further efforts in this regard are to be encouraged to help us better assess progress and redirect our efforts where needed. At present, however, most states do not have the staff required to do such investigations because of the large number of cases. As mentioned previously, the more activity required here, the less successful our routine immunizations at 1 year of age program has obviously been. Few

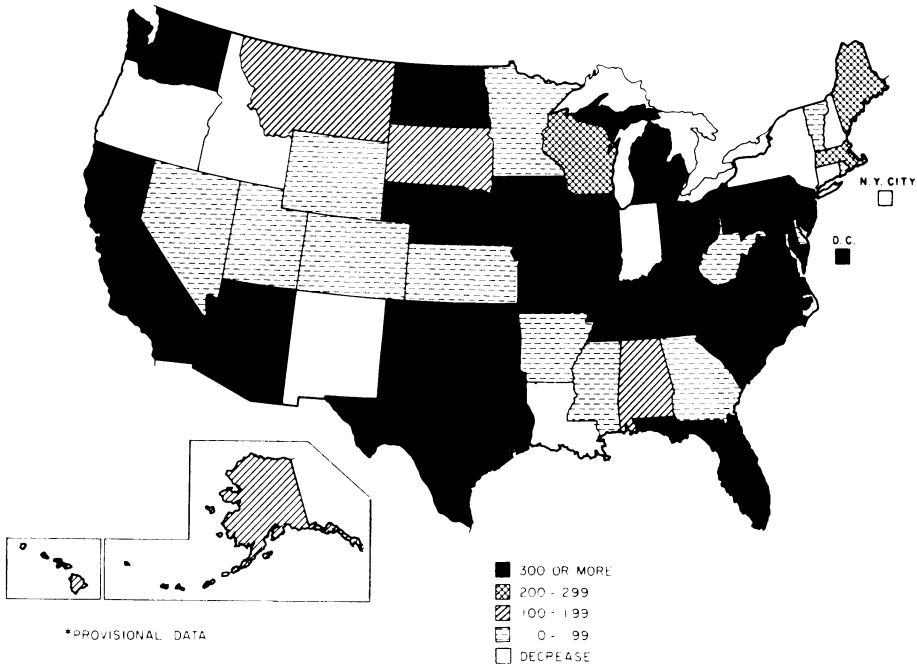
Table 1—Measles morbidity, epidemiologic years 1968–1969 and 1969–1970[1]

State	Epidemiologic Year 1968-69 Oct. 6 – Oct. 4	Epidemiologic Year* 1969-70 Oct. 5 – Oct. 10	Increase or (Decrease)	Percent Increase 1969-70
Alabama	7	108	+101	1,442.9
Alaska	11	145	+134	1,218.2
Arizona	405	1,127	+722	178.3
Arkansas	16	30	+14	87.5
California	951	1,762	+811	85.3
Colorado	152	184	+32	21.1
Connecticut	713	127	−586	
Delaware	400	402	+2	0.5
District of Columbia	25	477	+452	1,808.0
Florida	604	1,498	+894	148.0
Georgia	2	14	+12	600.0
Hawaii	41	198	+157	382.9
Idaho	89	54	−35	
Illinois	629	3,781	+3,152	501.1
Indiana	528	302	−226	
Iowa	395	1,172	+777	196.7
Kansas	7	78	+71	1,014.3
Kentucky	73	802	+729	998.6
Louisiana	123	113	−10	
Maine	9	225	+216	2,400.0
Maryland	79	1,416	+1,337	1,692.4
Massachusetts	244	444	+200	82.0
Michigan	376	1,850	+1,474	392.0
Minnesota	11	41	+30	272.7
Mississippi	25	90	+65	260.0
Missouri	30	1,277	+1,247	4,156.7
Montana	35	143	+108	308.6
Nebraska	218	1,888	+1,670	766.1
Nevada	4	21	+17	425.0
New Hampshire	248	63	−185	
New Jersey	1,014	1,981	+967	95.4
New Mexico	327	253	−74	
New York	5,962	1,355	−4,607	
North Carolina	356	961	+605	169.9
North Dakota	22	378	+356	1,618.2
Ohio	426	3,984	+3,558	835.2
Oklahoma	151	514	+363	240.4
Oregon	263	236	−27	
Pennsylvania	1,185	2,180	+995	84.0
Rhode Island	115	126	+11	9.6
South Carolina	142	612	+470	331.0
South Dakota	3	144	+141	4,700.0
Tennessee	20	390	+370	1,850.0
Texas	4,860	7,675	+2,815	57.9
Utah	10	36	+26	260.0
Vermont	5	8	+3	60.0
Virginia	1,045	2,110	+1,065	101.9
Washington	128	538	+410	320.3
West Virginia	254	334	+80	31.5
Wisconsin	756	1,049	+293	38.8
Wyoming	3	11	+8	266.7
Totals	23,497	44,707	+21,210	90.3
Puerto Rico				

[1] Provisional figures.

* Adjusted for 53rd week.

Figure 3—States showing increase or decrease of measles cases for epidemiologic year 1969–70, October 5, 1969-October 10, 1970,* over the epidemiologic year 1968–69, October 6, 1968-October 4, 1969



states or localities require name, age, and address of patients to be reported as part of the case report. To require this information might encourage better reporting at the grassroots level.

d) Epidemic control. Since establishment of the epidemic aid vaccine stockpile in 1966, approximately 40 requests have been received per year and 521,000 doses of measles vaccine have been issued from CDC on emergency request from State Health Departments. Most of these requests have centered around kindergarten or primary school epidemics, which, of course, signifies that children are not being required to be immunized before attending school.

Discussion and Conclusions

We have failed in our four-point measles eradication program. Yet there is no reason to suspect that the vaccine itself is at fault. Last year a group of children were reported who had been followed 8 years after receiving Edmonston B strain measles vaccine. Vaccine-induced antibodies have persisted for the entire duration, and not a single case of measles has occurred in the group.

Investigations of reports of vaccine failure in several states have reassured us further about measles vaccine. These so-called failures could be traced to: Immunization of children prior to 9 months of age, or prior to 1 year with gamma globulin; faulty handling of vaccine prior to administration; or finally, the known 3 to 5 per cent sero-conversion failure rate associated with all measles vaccines. No evidence has arisen to suggest that the more recent further attenuated virus strain will not be equally effective.

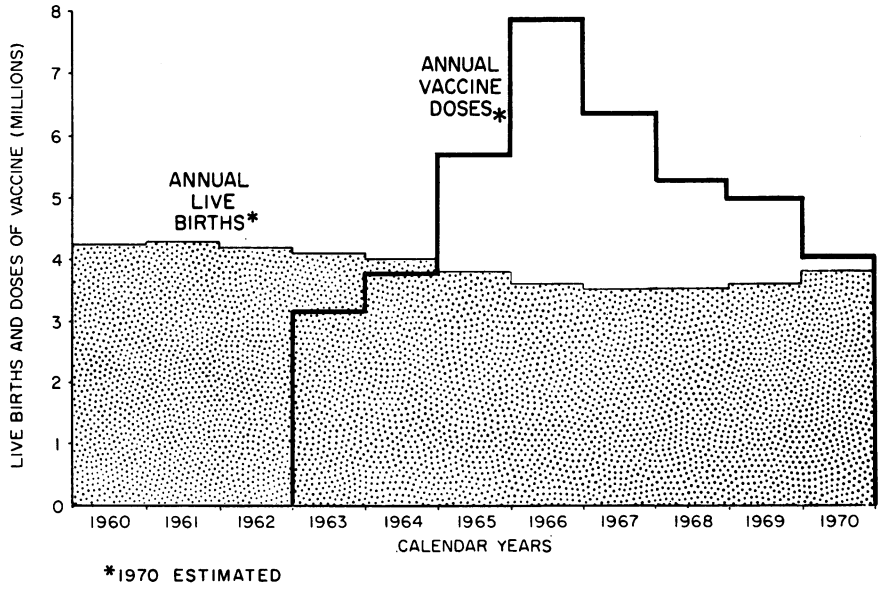
This, however, should not signal an

end to intensive surveillance of vaccine usage if its continued effectiveness is to be assured. Many unanswered questions remain, such as the role of vaccinees in the transmission of wild measles virus to susceptibles. Of course, surveillance of untoward vaccine reactions should be maintained to monitor possible alterations or contaminants of the vaccine virus.

A host of excuses and administrative problems with changing priorities have come up to block our progress. But no scientific reason has yet arisen to make us believe that eradication of measles is not possible. The reasons for measles eradication remain as important as ever. Deaths still do occur from measles at the rate of one per thousand reported cases; that comes to an estimated 40 deaths in 1970. Measles encephalitis with mental retardation still occurs at a rate of one per thousand reported cases; that's 40 for 1970. There are untold cases of pneumonia, as well as thousands of days missed from school, and thousands of physician and hospital visits every year.

Let us return to the four points recommended 4 years ago and emphasize the one perhaps absolutely crucial point, immunization of all children at 1 year of age, regardless of their geographic or sociologic location in our United States. If our problem is one of delivery of health services that has led to our failure to vaccinate the disadvantaged in our city centers, then we need to attack this with emphasis and vigor. If it is the difficulty of delivery of vaccine to rural populations without adequate medical services that has led to our failure there, then perhaps we need to recruit other than physicians to vaccinate these children. These are soluble problems. I do not believe we can rest on a 72 per cent measles immunity level for the U.S. as a whole, hoping that the elusive "herd immunity" will come to our aid eventually. Experience to date would make me believe that an adequate "herd immunity" level exists perhaps somewhere

Figure 4—Live births in the United States by year, 1960–1970, and distribution of live measles virus vaccine for domestic and military use by year, 1963–1970



above the 90 per cent level, if it exists at all. In terms of numbers, perhaps 12 million more children need to be immunized. Yet in Figure 4, you will note vaccine distribution is dropping off as cases continue to increase, and the oncoming births continue relatively steadily. If this trend continues, we can expect a major measles problem for the next several years.

It is up to us in Public Health to warn of such problems. Whether we can also effect a response in time remains to be seen.

REFERENCE

1. Sencer, D. J.; Dull, H. B.; and Langmuir, A. D. Epidemiologic basis for eradication of measles in 1967. Public Health Rep. 82,3: 253-256, 1967.

Dr. Conrad is Chief, Field Services Branch, Epidemiology Program, and Assistant Chief, Immunization Branch, State and Community Services Division, Center for Disease Control, Atlanta, Ga. Dr. Wallace is Clinical Instructor, Department of Social and Preventive Medicine, SUNYAB, and member, Vaccination Evaluation Unit. Dr. Witte is Chief, Immunization Branch, State and Community Services Division, Center for Disease Control, 1600 Clifton Rd., Atlanta, Ga. 30333.

This paper was prepared for presentation before the Epidemiology Section of the American Public Health Association at the Ninety-Eighth Annual Meeting in Houston, Tex., October 28, 1970.