Journal of Public Health

Does the administration of live poliovirus vaccine result in the spread of the induced infection to susceptible associates? This study endeavors to supply an answer to this important question. A large proportion of the contact children in the investigation were not infected and the reasons are discussed.

THE SPREAD OF LIVING ATTENUATED STRAINS OF POLIOVIRUSES IN TWO COMMUNITIES IN SOUTHERN LOUISIANA

Henry M. Gelfand, M.D., M.P.H.; Dorothy R. LeBlanc, R.N., M.P.H., F.A.P.H.A.; Louis Potash, Ph.D.; Dorothy I. Clemmer, Ph.D.; and John P. Fox, M.D., Ph.D., M.P.H., F.A.P.H.A.

THAT IMMUNIZATION against poliomyelitis remains a problem of some importance is evident from the fact that, despite the widespread availability and use of formalin-inactivated (Salk-type) vaccine, the United States has seen a significant increase in paralytic disease in 1959 over the two previous years. This relative failure of the Salk vaccine has served to enhance interest in the practicality of immunization by means of infection with living, attenuated vaccine strains of polioviruses.

The possible advantages of the live-virus vaccines, in part still theoretical and in part readily demonstrable, depend largely on the fact that the vaccine strains may simulate natural infection. They should be cheaper to produce; they are fed rather than injected; a single administration should result in prompt and uniform development of immunity which, hopefully, will be of indefinitely long duration; and this immunity to disease should be associated with relative resistance to future alimentary tract infection, a result not observed with immunity induced by Salk vaccine.[1] Because of this latter advantage, extensive but incomplete live-virus vaccination of the population should raise a barrier to the spread of "wild" polioviruses and so afford some protection to those not yet immunized. It may be noted further that large-scale trials involving several millions of people

which are currently under way[2] provide rather convincing evidence as to primary safety in the vaccinated individual and may produce future data as to effectiveness under field conditions.

Ironically, the most serious concern regarding live-virus vaccines derives from the possibility that the vaccine-induced infection may simulate natural infection too closely. Specifically, there is ample reason to believe that the infected vaccinee may transmit the infection to his susceptible associates. This would be a decided advantage and would, in fact, exemplify a new principle of vaccine-induced "herd protection," if the spreading vaccine virus remains safely attenuated. In the contrary case, such spread of vaccine virus would be a potential danger. Two types of study should help to resolve this concern. One of these, centered about the phenomenon of vaccine virus variability, is currently under study in various laboratories.[2] The other is the study of the extent of vaccine virus spread under varying circumstances.

Extensive spread has been observed in closed institutions[3] and several studies have described spread within households.[4-6] In one such study,[6] the present authors determined that socioeconomic status, presumably as it reflects household and personal hygiene, was the single most important attribute associated with intrafamilial spread. We further noted interfamilial spread and commented on the "possibility that an entire community might be saturated with these strains if they were administered to a sufficiently large proportion of the susceptible children present."[6]

Community spread of polio vaccine virus strains has probably often occurred during field trials,[7,8] and was studied in detail in a small, winter-time trial in a completely isolated, island population in Finland.[9] During the latter investigation no enterovirus infections were naturally occurring, and it was possible to show serologically that spread of the type 1 vaccine strain had occurred among one-third of the unvaccinated group. Another study specifically designed to investigate vaccine virus dissemination on a community basis, made in an Amerindian village by Horstmann and co-workers,[10] failed to show any spread because of the high level of pre-existing natural immunity against the type 1 virus used and perhaps also because of the intensive concurrent circulation of other enteroviruses.

Because of the importance of the problem and because no previous study had been designed for or was successful in answering specifically the question, "May it be anticipated that appreciable dissemination of living poliovirus vaccine strains will occur under optimal conditions in a normal, unmanipulated United States community?," the study reported here was undertaken. This communication is only a preliminary report of the results; a great deal remains to be done in the study and analysis of the large volume of material collected. However, the general pattern already appears clear, and the interest of the subject would appear to justify early presentation.

Methods and Materials

General Plan of the Study

The general plan entailed the recruitment into the study of a number of family units in each of several typical, well defined, cohesive, lower economic communities with large child populations in southern Louisiana within several hours traveling time from New Orleans. From one to two months in advance of the actual initiation of the study, the nurse-epidemiologist (D.R.L.) visited areas that had been selected on the basis of her knowledge of the physical and social characteristics of communities in the region and our general impressions of the probable status of

poliovirus seroimmunity patterns derived from previous investigations.[1] During these visits, she explained the program, obtained written statements of willingness to participate from both parents, and collected essential medical and sociological data, including a detailed Salk-vaccination history (later confirmed by reference to official public health records), and blood specimens from each member of the recruited families.

In the laboratory, the sera were "screened" for the presence of neutralizing antibodies against all three types of polioviruses. On the basis of the serological results, history of previous vaccine administration, and other evidence (see below), a presumption of natural susceptibility or immunity was made with reference to each virus type for each child. After review of the past experience of the group with each of the three types, the type offering the greatest number of susceptible children was determined in order to decide which type of vaccine virus could best be used to study spread.

The study group of families in each community was then divided into two subgroups, one to be fed the selected type of vaccine virus and the other a similar-appearing placebo salt solution. The subdivision was not made on a random basis, but was without reference to the nurse or to any other source of information relative to sanitary or hygienic status, interfamilial social relationships, or other individual factors of importance in transmission. The families were paired only on the basis of: (1) the number of susceptible children (child meaning 15 years of age or younger) of equivalent age; and (2) geographic location in the community in order to insure that the vaccinated families were widely scattered. A personal census of all children in the communities was made to permit calculation of the percentage of children fed vaccine.

Early in June, 1959, after school had been dismissed, the administration of vaccine and placebo was begun. Each child in the "vaccine-fed" families received vaccine, and each child in the "placebo-fed" families received the saline placebo; the feeding unit was therefore a family rather than an individual. The parents knew that their children might be receiving either vaccine or placebo but did not know which in fact was fed. Blood specimens were collected from every child in the study at the time of vaccine administration. The feeding-bleeding procedure lasted two days in each of the communities.

On or just before the day of feeding, a fecal sample was collected from each study child. During the following three months (June, July, and August), collections were to be twice weekly. Despite frequent gifts of candy, chewing gum, and small coins to stimulate their interest and cooperation, there was considerable variation from child to child in the consistency with which specimens were collected. The nurse-epidemiologist left a supply of labeled ointment jars with each family for the fecal specimens, and visited once a week in order to collect the filled containers and to discuss with the mother the occurrence of illness in her family and significant social activities of her children.

The trial was terminated at the end of August, just before the opening of school. A terminal blood specimen was collected from every person in the study, and all participants were fed trivalent Sabin vaccine as a promised reward.

Characteristics of the Communities and Recruitment of Study Groups

Suitable communities were found in the towns of Morgan City and Franklin, La. Each is a distinct neighborhood, not isolated from the remainder of the town, but bounded by physical features such as a highway, a school, railroad tracks, and others, so that a relatively homogeneous play community is pro-

duced. The population of the Morgan City locale is almost entirely Negro and that of Franklin entirely so; both populations belong to the lower economic group. The level of environmental sanitation is low, and many of the homes are served by outdoor privies. With a few striking family exceptions, the general level of personal hygiene is very low, and the majority of the children appear ragged and unwashed. Large families are common, and social intermingling is intense, particularly among the children, whose activities carry them from home to home and from street to street. Many of the families are genetically related.

Recruitment of families into active participation was informally random. The nurse was instructed only to insure wide geographic sampling. Willingness to participate and the presence of children in the family were the only household prerequisites; there was no conscious selection on any other characteristic. The nurse was often attracted by groups of children, and was frequently guided to their homes by the curious. The parents were almost equally curious and friendly, and, after long, informal discussion of the project, refusals were infrequent. After the goal of 25 to 30 family recruits had been attained in each area, there appeared to be no obvious differences between families in the study group and those in the remainder of the neighborhood.

The physical extent of the Morgan City and Franklin study communities is shown in the outline maps in Figure 1, which also indicate the distribution of households without children, those with children but not included in the study, and vaccine-fed and placebo-fed families. The Morgan City study area included 133 households of which 12 and 13 were fed vaccine and placebo, respectively, and 332 children of which 55 (17 per cent) and 69 were fed vaccine and placebo, respectively. The Franklin study area was smaller and included 75 households of which 13 each were fed vaccine and placebo, and 130 children of which 56 (43 per cent) and 51 were fed vaccine aind placebo, respectively.

Vaccine Strains and Administration

Virus strains of all three types were kindly provided by Dr. Albert Sabin from the large pools that had fulfilled his rigid criteria for purity and attenuation.[11] Because of the specific status of group immunity found in the study communities, only the type 3 (Leon 12 a_1b) was used. It was administered undiluted, and therefore contained approximately 7.3 log doses (20 million tissue culture infectious particles) per ml as titrated in rhesus monkey kidney cell tissue cultures. The stock vaccine was distributed into sterile, screw-topped vials, in such quantity that one or two vials contained the material to be used for an entire family. The vials were labeled with the family identification and held at $-20°C$ until immediately before use. Placebo saline with phenol red was packaged in exactly the same manner.

Oral administration was done in the home by squirting 1 ml of material from the labeled vial into the back of the mouth of each child in the study family. Medicine droppers were used for administration, and care was taken to avoid carrying infectious material from one home to another.

Laboratory Procedures

Rhesus monkey kidney cell tissue cultures, prepared locally, were employed throughout, utilizing technics now standard.[1]

Stool specimens were processed into 10 to 20 per cent fecal extracts, and the latter were inoculated into tissue culture tubes for virus isolation and identification, also using standard tech-

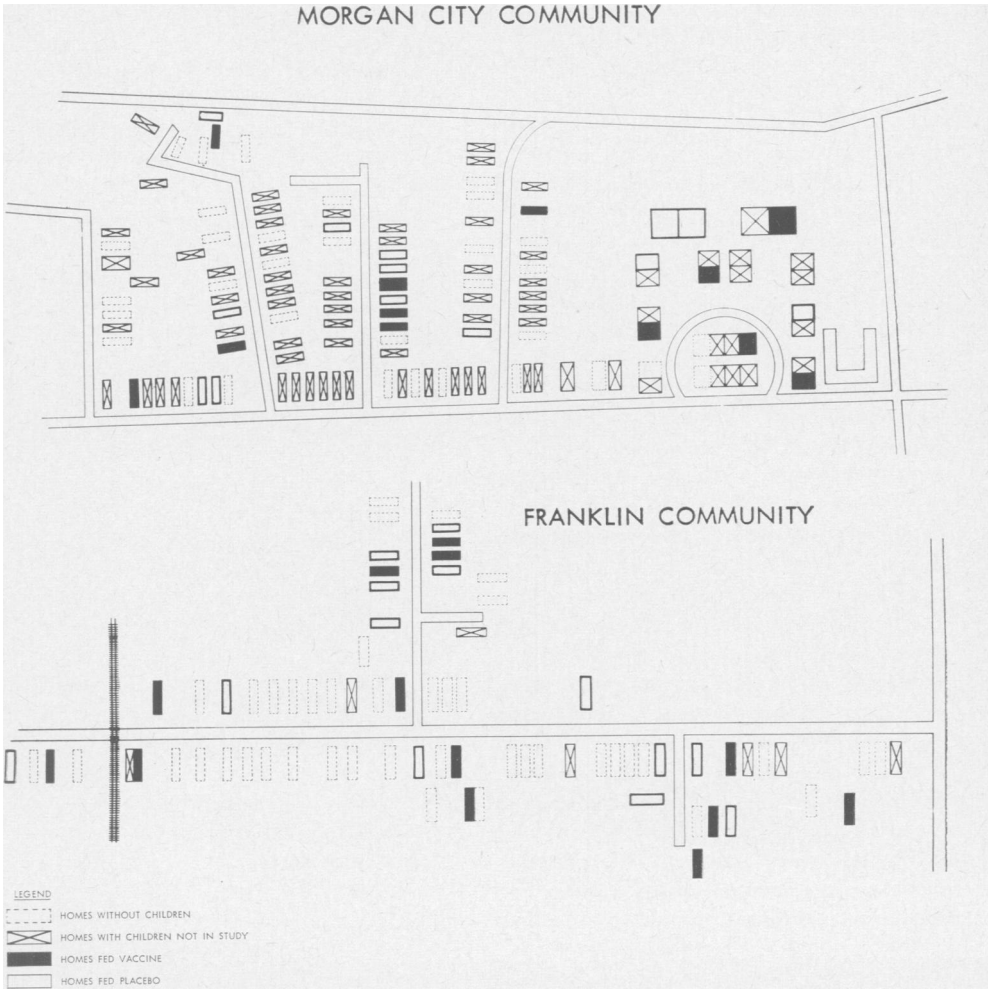
nics that have been reported in detail elsewhere.[6]

Sera were tested for the presence of neutralizing antibodies by direct, microscopic examination for the inhibition of cytopathology. For the purposes of this report, only serum specimens collected from one to two months prior to the initiation of the vaccination were tested, and only for polioantibodies. Sera were diluted 1:2 and 1:8, and aliquots of each were incubated for one hour at room temperature with an equal quantity of virus suspension calculated to contain approximately 100 $TCID_{50}$ per 0.1 ml. The mixtures were then inoculated into two culture tubes per dilution. End points are expressed as of the final serum dilution.

Results

Sera collected in April and May, 1959, were "screened" for polioantibodies, using serum dilutions yielding final end points ranging from $<1:4$

Figure 1



through >1:16. Since many of the children had received one, two, three, or four Salk-vaccine "shots," criteria had to be established, and the decision made prior to vaccine administration, as to the natural susceptibility (meaning no prior infection with the virus type in question) or immunity of each child to each virus type. The following rules governed the decisions:

1. Any antibody titer of 1:8 or less was presumed to indicate susceptibility regardless of Salk-vaccination status. (With only rare exceptions, where no vaccination had been recorded, titers were <1:4.)

2. Any antibody titer of 1:16 or greater was presumed to indicate the immunity of natural infection if no Salk vaccination was recorded, except in the cases of two very young infants whose naturally acquired antibodies were presumed to be of maternal origin.

3. When titers of 1:8 or greater were accompanied by a record of Salk vaccination, the presumption for the child was reached on circumstantial evidence such as the number of Salk "shots," his own heterologous polio experience, and indications of the time of the most recent familial experience with the homotypic virus as provided by the apparent immunity status of his older and younger siblings.

On the basis of these criteria, there appeared to be a larger number of children susceptible to type 3 poliovirus, in both communities, than to either of the other types. Nearly all children below six years of age and a significant proportion of the older group were judged susceptible. For this reason, type 3 vaccine virus was chosen as the strain most suitable for the study of dissemination in both communities.

Because susceptibility to infection with live-virus vaccine is closely related to the natural status of susceptibility or immunity,[5] it would have been highly desirable to have had some direct method of verifying the decision made for each individual based on the criteria given above. Since there is no such method, the next best thing was a retrospective evaluation of the "presumed-susceptible" and "presumed-immune" groups among the vaccine-fed children by considering the occurrence and duration of fecal excretion of poliovirus type 3 following a constant challenge dose. Examination of the viral excretion record reveals that the great majority of those who were believed to be susceptible experienced a duration of excretion in excess of two weeks, whereas, among those thought to be immune, the great majority excreted for less than two weeks. Moreover, most of these immunes who excreted over a longer period of time did so intermittently, with only an occasional "positive" specimen interspersed between many "negatives." Although it cannot be made applicable to each individual, this examination clearly indicated that the presumption of susceptibility or immunity was confirmed in general for the vaccine-fed group, and therefore should be considered as having been correct in general for the placebo-fed contacts.

Excretion of Homologous Virus by Vaccine-Fed Children

Table 1 is a summary of infections, as detected only by the recovery of homologous poliovirus in the feces, among the susceptible and immune children who were fed Sabin's type 3 vaccine strain directly. In both communities, the percentage of infection was higher among susceptibles than among immunes, although the great majority of immunes did become infected. Every susceptible child was successfully infected in the Morgan City group, but 7 of 38 failed to excrete in Franklin. These failures may be explained in part by interference caused by concurrent infection with other enteroviruses (see below), and in part may have resulted from an incorrect presumption of susceptibility.

Spread of Infection to Placebo-Fed Children

The number of susceptible vaccine- and placebo-fed children observed to

be excreting poliovirus type 3 during each of the first seven or eight weeks of the observation period is shown in Table 2. When feeding of vaccine resulted in infection, fecal excretion of virus was begun in the first week by all but three children. The number excreting virus declined during succeeding weeks, but at least 5 out of 54 were still excreting during the seventh week. Among placebo-fed children, infections occurred more frequently in the Franklin community than in Morgan City. Of the total of 26 ultimately shown to have become infected, eight were excreting during the first week after vaccine was administered to their playmates. Additional new infections (see also Table 4) were detected through but, so far, not after the fifth week. The number excreting virus reached its peak in this week also.

Infections among susceptible and immune placebo-fed children, as detected only by fecal virus excretion, are distributed by age in Table 3. The greater proportion of excretors is in children under five years of age, nearly all of whom were assigned to the susceptible category. Among children five years and older, fewer excretors were detected in general and the relative frequencies among the susceptible and immune groups did not differ greatly. It seems likely that erroneous presumption as to susceptibility may explain in part this observation of small difference. The greater over-all percentage of contact infection found in Franklin, 37 per cent versus 25 per cent in Morgan City, also is to be noted. This result may well be related to the fact that the seeding of vaccine virus was much more intense in the Franklin community (vaccine fed to 43 per cent of all children) than in Morgan City (only 17 per cent of children were fed). While serological examination of the blood specimens collected during the twelfth week after vaccine administration may show that additional individuals have experienced contact infections, our previous experience[6] suggests that the number will be small and so will not change the above pattern appreciably.

Once introduced into a contact family, infection did not necessarily spread to involve all of the susceptible children present. In only five of ten instances in which spread could have occurred did all susceptible children become infected. In five additional families, in-

Table 1—Excretion of Homologous Poliovirus by Vaccine-Fed Children, by Years of Age

Age in Years	Morgan City Community						Franklin Community					
	Susceptible*		Immune*		Both		Susceptible*		Immune*		Both	
	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting
<1	6	6	0	–	6	6	2	2	0	–	2	2
1	2	2	0	–	2	2	3	3	0	–	3	3
2	8	8	0	–	8	8	5	4	0	–	5	4
3	4	4	0	–	4	4	3	2	0	–	3	2
4	4	4	1	1	5	5	4	4	0	–	4	4
5	0	–	1	1	1	1	4	3	0	–	4	3
6–9	2	2	12	7	14	9	11	9	10	8	21	17
10–15	7	7	8	7	15	14	6	4	8	5	14	9
Total	33	33	22	16	55	49	38	31	18	13	56	44
(% Excreting)		(100)		(73)		(89)		(89)		(72)		(79)

* Susceptibility presumed on basis of criteria given in text.

Table 2—Summary of Susceptible Children* Found Excreting Homologous Virus During Eight Weeks After Feeding Sabin Vaccine Type 3

Community	Material Fed	Number of Susceptible Children	Number of Susceptible Children Excreting Poliovirus Type 3 During Indicated Week								
			Before Feeding	1	2	3	4	5	6	7	8	At Any Time
Morgan City	Vaccine	33	0	32	31	24	22	16	(7/29)	(3/25)	(3/25)	33
	Placebo	34	0	1	5	4	6	(6/32)†	(4/32)	(4/28)	(3/22)	10
Franklin	Vaccine	38	0	29	26	16	13	(9/36)	(4/29)	(2/29)		31
	Placebo	33	0	7	8	8	8	9	(5/30)	(2/24)		16

* Susceptibility presumed on basis of criteria given in text.
† Ratios are given where studies are still incomplete and less than the total number of children can be included; numerator is number of children excreting, denominator is number of children studied.

fection was confined to the single susceptible child present (three instances) or to a single presumed-immune (two instances). Thus, infection spread to a total of 15 or 58 per cent of the 26 placebo-fed families in both communities. This relatively widespread distribution of the virus among families is in contrast with the more limited distribution among children as noted above. It should also be mentioned, although the data are not yet sufficiently complete to be reported in detail, that the duration of fecal excretion among contacts appears in general to have been significantly shorter than among vaccine-fed children. This is in agreement with our finding in previous studies of intrafamilial spread[6] where the duration of fecal excretion among family contacts was often very abbreviated.

Other Enterovirus Infections Detected in Study Families

Table 4 shows, for each study family in both communities, the week after vaccine feeding during which fecal excretion of a given enterovirus type was first detected. The occurrence of type 3 poliovirus has been noted above. However, several other enteroviruses also were encountered. As the vaccine strains were being fed, Coxsackie B2 virus was present in both communities in a total of 11 households—three in Morgan City and eight in Franklin; in addition, type 1 poliovirus and Coxsackie B3 were present in two and one households, respectively. Subsequently, poliovirus type 1 was no longer found, but Coxsackie B2 virus spread to five other families through the third postvaccination week. Coxsackie B3 had been infecting all of six children in household 28 in Franklin just prior to vaccine feeding but was replaced in each instance by the vaccine virus and was not recovered again from these children or from any Franklin child. However, in Morgan City this virus appeared in three families during the third postfeeding week and has continued to spread, involving one new family per week, thereafter. Untyped adenoviruses were recovered from two households, and one or more enteroviruses, as yet unidentified but other than P3, B2, or B3, were isolated from three families.

In contrast to the often sporadic occurrence of the vaccine strain of poliovirus type 3 in only one or a few children in a contact family, the familial pattern of the Coxsackie types was usually more typical of enterovirus distribution, i.e., across-the-board involvement of all of the younger members of an infected family.

On many occasions, two or more

virus types were recovered from different individuals in the same family at the same time. Where this occurred, the phenomenon of viral interference was often suggested. Final analysis must await more complete study of the available fecal and serum specimens, but there is a great likelihood that the presence of other enteroviruses prevented some contact infections with the vaccine strain. Interference may even have prevented some primary infections among those who were fed the large vaccine inoculum used in this study. A possible example of this phenomenon is presented in Table 5.

Illness

Frequent interrogation of the mothers by the nurse-epidemiologist revealed no episode of illness which could be associated with poliovirus infection. However, a coincidental episode was observed in one Morgan City family which could have marred the vaccine safety record. In this family, all six children developed illness characterized by vomiting, diarrhea, and fever, encompassing the period from the day of vaccine administration until ten days later. Fortunately, this was a placebo-fed family, and from none of the children was a poliovirus or other enterovirus isolated at that time or thereafter during the following two months.

Discussion

The question which this study was designed to answer was, "May it be anticipated that appreciable dissemination of living poliovirus vaccine strains will occur under optimal conditions in a normal, unmanipulated U. S. community?" The factors intended to insure optimal conditions for spread in the Morgan City and Franklin groups were seasonal, immunologic, virologic, and social. The summer months encompass the period of maximal "wild" poliovirus prevalence;[1] a high proportion of children, especially of those below five years of age, appeared to be naturally susceptible to the type 3 poliovirus administered; this type 3 vaccine strain was observed to have a capacity for intrahousehold spread at least equal to and probably greater than that of the other two components of the Sabin vaccine;[6] and finally, the vaccine virus

Table 3—Excretion of Homologous Poliovirus by Placebo-Fed Children, by Years of Age

Age in Years	Morgan City Community						Franklin Community					
	Susceptible*		Immune*		Both		Susceptible*		Immune*		Both	
	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting	No.	No. Excreting
<1	6	2	0	–	6	2	2	2	0	–	2	2
1	4	0	0	–	4	0	3	2	0	–	3	2
2	5	2	0	–	5	2	5	4	0	–	5	4
3	3	2	0	–	3	2	2	2	1	0	3	2
4	5	2	0	–	5	2	4	1	3	1	7	2
5	3	1	2	0	5	1	5	2	2	0	7	2
6–9	5	0	17	5	22	5	5	2	7	2	12	4
10–15	3	1	16	2	19	3	7	1	5	0	12	1
Total	34	10	35	7	69	17	33	16	18	3	51	19
(% Excreting)		(29)		(20)		(25)		(48)		(17)		(37)

* Susceptibility presumed on basis of criteria given in text.

Table 4—Summary of First Isolation of Virus of Given Type* in Household Units Studied

Morgan City									Franklin							
	Enterovirus Detected During Indicated Week									Enterovirus Detected During Indicated Week						
Unit Number	Before Feeding	1	2	3	4	5	6	7	Unit Number	Before Feeding	1	2	3	4	5	6
A. Vaccine-Fed Families																
2		P3				B3			28	B3	P3					
3		P3							30	B2	P3					
4		P3							31	B2	P3					
7		P3							33		P3					
8		P3		B2				B3	39		P3					
11	P1	P3	Un						40		P3					
12		P3							45	B2	P3				Un	
13	P1–B2†	P3		B3					46		P3					
16		P3							47		P3					
20		P3							48		P3					
25		P3							50	B2	P3					
26		P3							52		P3					
									54		P3					
B. Placebo-Fed Families																
1				P3–B2†					27	B2	P3					
5						P3			29		P3–B2†					
6									32	B2	P3					
10			P3–Ad†						34	B2						
14				B3	P3				36						Un	
15					B3				37							
17									38							
18			P3	B3					41		P3	Ad				
19	B2								42		B2	P3				
21							B3		43				P3			
22	B2								44							
23		P3–B2†							49	B2					P3	
24			P3						51		P3					

* "P1" is poliovirus type 1; "P3" is poliovirus type 3; "B2" is Coxsackie virus type B2; "B3" is Coxsackie virus type B3; "Ad" is untyped Adenovirus; "Un" is an enterovirus not yet typed, but not P3, B2, or B3.

† Each virus type in a separate individual.

in maximal doses was widely seeded in poorly sanitated and lower economic communities in which the usual intense social intercourse gave promise of fully adequate opportunity for virus transmission. The study was initiated, therefore, with the expectation that "an explosion of transmission" would lead to prompt saturation of the populations with type 3 virus. The results are quite different, and are the more impressive because unexpected.

Although primary infection of susceptible children was largely successful, spread in both communities considered together has so far reached only 58 per cent of placebo-fed families, 39 per cent of susceptible contact children, and 19 per cent of immune contact children. Moreover, many of these infected contacts excreted so briefly that they could hardly have served as effective sources for further spread and their infections may have failed to stimulate either antibody or local intestinal resistance.

The failure of the vaccine strain to achieve the expected population saturation during the period of observation cannot be explained entirely on the basis of interference by the other enteroviruses which were found to be concurrently present, since (see Table 4) many placebo-fed families experienced infection with neither "wild" enterovirus nor vaccine virus. Our prior observations of intrahousehold spread[6] indicated clearly that the vaccine strains spread within households much less readily than did "wild" poliovirus strains, and it now appears probable that even the type 3 strain lacks sufficient infectivity to permit establishing an indefinite and self-maintaining chain of transmission in the community. To the extent that this observation is confirmed by future experience, concern with possible enhancement of the pathogenicity of the vaccine virus during human passage may be minimized. At the same time, however, there seems little further ground for hoping that partial seeding of a population can be relied on to result in complete vaccination; indeed, we may well wonder if we can depend on involuntary transmission to reach the minority of children who would be missed during mass vaccination campaigns.

The "wild" enteroviruses encountered merit a final note of comment. With

Table 5—Sample Franklin Family to which Sabin's Poliovirus Type 3 Was Fed, Showing Failures to Infect Susceptible Children Possibly Explained by Interference by Concurrent "Wild" Enterovirus Infection

Age (Years)	Presumed* Immunity Status	Enterovirus† Isolated on Indicated Day After Feeding Sabin's Poliovirus Type 3						
		Before Feeding	4	6	8	12	15	19
12	Immune	–	–	–	–		–	–
11	Susceptible	B2	–	3	3	3	–	–
9	"	B2	3	3	3		3	–
6	"	B2	B2	B2	B2	–		–
5	"	B2	B2	–	B2	–	–	–
4	"	B2	B2	–		3	–	
3	"	–	3	3	3	3	–	–

* Susceptibility (to poliovirus type 3) presumed on basis of criteria given in text.
† "B2" indicates Coxsackie type B2; "3" indicates poliovirus type 3; "–" indicates no virus isolated; and a blank indicates no specimen collected.

the unusually large vaccine dose employed, 7.3 logs, 7 out of 71 susceptible children (10 per cent) escaped primary infection. Had the more usual dose of five or six logs been employed, the primary interference effect might have been greater. Indeed, one may speculate that the effect of other enteroviruses in blocking contact transmission of vaccine strains of polioviruses is likely to be still greater in view of the presumed smaller doses involved in such transmission.

Summary

Living, attenuated poliovirus type 3 (Sabin vaccine) was administered orally early in June to all children in a group of families in two lower economic Negro communities in southern Louisiana which prior serologic study had shown to lack widespread natural immunity to this virus type. At the same time, in a group of similar families chosen to be the indicators of contact infection, a placebo material was fed. Study of frequent, routine fecal specimens from all children served to indicate primary and contact infections. Excretion of homologous virus occurred in 90 per cent of vaccine-fed children, and in 39 per cent of contact children during the succeeding seven weeks. Many concurrent "wild" enterovirus infections were detected. The failure of the vaccine strain to infect a larger proportion of the contact children was attributed in part to viral interference and in larger part to a lower infectiousness of the vaccine strain as compared with "wild" polioviruses. No illness of any sort could be associated with primary or contact poliovirus infection.

REFERENCES

1. Gelfand, H. M.; LeBlanc, D. R.; Potash, L.; and Fox, J. P. Studies on the Development of Natural Immunity to Poliomyelitis in Louisiana. IV. Natural Infections with Polioviruses Following Immunization with a Formalin-Inactivated Vaccine. Am. J. Hyg. 70:312–327 (Nov.), 1959.
2. First International Conference on Live Poliovirus Vaccines, Washington, D. C., June 22–26, 1959. Pan Am. San. Bur. Sc. Publ. No. 44, 1959. 713 pp.
3. Horstmann, D. M.; Niederman, J. C.; and Paul, J. R. Attenuated Type 1 Poliovirus Vaccine. Its Capacity to Infect and to Spread from "Vaccinees" within an Institutional Population. J.A.M.A. 170:1–8 (May 2), 1959.
4. Martins da Silva, M.; McKelvey, J. L.; Prem, K. A.; Bauer, H.; Cooney, M. K.; and Johnson, E. A. Studies of Orally Administered Attenuated Live Virus Poliomyelitis Vaccine in Newborns and Infants Under Six Months. Univ. Minnesota M. Bull. 29:133–150 (Dec.), 1957.
5. Gard, S.; Böttiger, M.; and Lagercrantz, R. Vaccination with Attenuated Poliovirus Type 1, the Chat Strain. Presented at the Conference on Live Poliovirus Vaccines, Washington, D. C., June 22–26, 1959. Pan Am. San. Bur. Sc. Publ. No. 44, 1959, pp. 350–354.
6. Gelfand, H. M.; Potash, L.; LeBlanc, D. R.; and Fox, J. P. Intrafamilial and Interfamilial Spread of Living Vaccine Strains of Polioviruses. J.A.M.A. 170: 2039–2048 (Aug. 22), 1959.
7. Barr, R. N.; Bauer, H.; Kleinman, H.; Johnson, E. A.; Martins da Silva, M.; Kimball, A. C.; and Cooney, M. K. Use of Orally Administered Live Attenuated Polioviruses as a Vaccine in a Community Setting. Ibid. 170:893–905 (June 20), 1959.
8. Skovranek, V.; Zacek, K.; Vonka, V.; Adam, E.; Adamova, V.; Burian, V.; and Vojtova, H. Field Trial with Sabin's Live Poliovirus Vaccine in Czechoslovakia 1958/1959. Presented at the Conference on Live Poliovirus Vaccines, Washington, D. C., June 22–26, 1959. Pan Am. San. Bur. Sc. Publ. No. 44, 1959, pp. 530–571.
9. Oker-Blom, N.; Strandström, H.; and Eriksson, A. W. A Small-Scale Trial with Live Poliovirus Vaccine in an Isolated Island Community. Presented at the Conference on Live Poliovirus Vaccines, Washington, D. C., June 22–26, 1959. Ibid., pp. 580-587.
10. Horstmann, D. M.; Niederman, J. C.; Riordan, J. T.; and Paul, J. R. The Trial Use of Sabin's Attenuated Type 1 Poliovirus Vaccine in a Village in Southern Arizona. Am. J. Hyg. 70:169–184 (Sept.), 1959.
11. Sabin, A. B. Properties of Attenuated Polioviruses and Their Behavior in Human Beings. New York Acad. Sc. Spec. Publ. 5:113–127 (Dec.), 1957.

Dr. Gelfand is chief, Enterovirus Unit, Laboratory Branch, Communicable Disease Center, PHS, Chamblee, Ga. Dr. Potash is virologist, Research Laboratories, Merck Sharp and Dohme, West Point, Pa. Dr. Clemmer and Miss LeBlanc are instructors in epidemiology, and Dr. Fox is professor of epidemiology, Tulane University Medical School, New Orleans, La.

This paper was presented before the Epidemiology Section of the American Public Health Association at the Eighty-Seventh Annual Meeting in Atlantic City, N. J., on October 19, 1959.

This study was aided by a grant from the National Foundation.