In an effort to add to our knowledge of the utility of newborn vaccination with Sabin vaccine, an investigation was undertaken using the schedule recommended by the Surgeon General's Committee on Poliomyelitis Control. This is a report on the results concerned with Type 1 only.

IMMUNIZATION OF INFANTS WITH THE SABIN ORAL POLIOVIRUS VACCINE

Alfonso H. Holguin, M.D.; Joan S. Reeves, R.N.; and Henry M. Gelfand, M.D., M.P.H., F.A.P.H.A.

IT WOULD probably be agreed universally that the ideal prophylaxis against paralytic poliomyelitis would have been found if it were possible to administer a safe vaccine containing living, attenuated polioviruses of all three types to infants before discharge from a maternity hospital and thereby to cause infection with all three types, the active production of neutralizing antibodies, and life-long immunity. Unfortunately, the results of numerous studies since the first "feeding" of poliovirus vaccines to newborns in 1955 and 1956[1] have caused a continuous retreat from this ideal, based on findings of the newborn infant's relative resistance to infection and relative immunologic incompetence, and the competition and interference between virus types when they are administered simultaneously. The problem remaining at the present time, therefore, is to discover the maximum that may be accomplished in this convenient, medically captive group.

Based on experiences with various strains of attenuated polioviruses, used under varying conditions,[2-11] the following are some generally accepted principles of infant vaccination:

1. No harmful effects on vaccinees have been demonstrated.
2. Immunologic tolerance, i.e., inability to develop antibody later following exposure at an early age, does not develop.
3. A larger dose of vaccine than is routinely recommended is required to cause infection in a high percentage of newborns.
4. A proportion of newborns does become infected following vaccine "feeding," with prolonged virus excretion and specific antibody formation, but the proportion is lower than that which follows the same dose in older infants and children.
5. Infected newborns tend to excrete vaccine viruses for a shorter time and to develop antibody to lower titer than do older children.
6. The simultaneous administration of all three types often results in infection with only one or two types.

Major current disagreements are concerned with the effects of age itself within the first few months of life and of passive antibody acquired from the mother. Ultimately we must be able to determine what proportion of newborns does become immunized by early vaccination, and whether this proportion justifies the procedure.

In an attempt to add to our knowledge of the utility of newborn vaccination the present investigation was undertaken, following, for the most part, the schedule of vaccine administration tentatively recommended in January, 1961, by the Subcommittee on Primary Immunization of the Agenda Committee

of the Surgeon General's Committee on Poliomyelitis Control:

Vaccine Type	Age	Plaque Forming Units (PFU)
1	0-3 days	5,000,000
1	6 weeks	500,000
3	3 months	500,000
2	4½ months	500,000
1, 2, and 3	10-12 months	500,000 of each type

Since the study has not yet been completed for all poliovirus types, this preliminary report will be concerned with Type 1 only. The final, "cleanup" dose of trivalent vaccine has not yet been given to any of these children.

Materials and Methods

Study Group

Mothers of a lower economic group were recruited shortly after the uncomplicated delivery of a normal, full-term baby in Grady Memorial Hospital, Atlanta, Ga.* Agreements-to-participate were signed. Fifteen infants were selected each month from December, 1960, through June, 1961, a total of 105. The slow rate of recruitment insured that vaccine of all three types would be administered during all seasons of the year in order to detect and equalize interference by "wild" enteroviruses, should any occur.

The group vaccinated each month was subdivided among several vaccination schedules, resulting in the final subgroups shown in Table 1. These schedules include two modifications of the recommended regimen. First, the repeat dose of Type 1 was given at either six weeks or three months in order to detect any advantage relating to delayed refeeding. Second, some infants received a mixture of Types 1 and 3 at birth (10X concentration of each) in order to determine whether infection with and multiplication of these types could proceed simultaneously.

Vaccine Administration

Vaccine was kindly provided by Dr. Albert Sabin from single large pools designated LSc2ab (Type 1), P712, Ch2ab (Type 2), and Leon 12 a_1 b (Type 3).[12] All of the vials of each type were thawed, emptied and pooled, diluted in Hanks' BSS as necessary to obtain the desired PFU count in 1 ml, and distributed in that amount in individual screw-top vials which were then stored at −15° C until just before use. Divalent vaccine (Types 1 + 3) consisted of 2 ml containing 1 ml each

* The generous cooperation of the administrative, medical, and nursing personnel of the hospital is gratefully acknowledged.

Table 1—Vaccination Schedule Subgroups

Schedule	Type(s) "Fed" at Indicated Age†					No. Infants "Fed"
	Birth*	6 Weeks	3 Months	4½ Months	6 Months	
A	1	1	3	2	–	55
B	1	–	1	3	2	25
Subtotal						80
C	1 and 3	1	3	2	–	11
D	1 and 3	–	1	3	2	14
Subtotal						25

* Tenfold concentration of indicated virus type(s).
† All babies will receive trivalent vaccine (Types 1, 2, and 3) at 10-12 months of age.

Table 2—Duration of Virus Excretion Following First Vaccine Dose, Relationship to Maternal Antibody Titer

Maternal Antibody Titer*	Monovalent Type 1 Vaccine: No. of Infants	No. Excreting Type 1 Virus for Indicated No. of Days: 5-8	10-11	≥14	Total % Excreting	Divalent Types 1+3 Vaccine: No. of Infants	No. Excreting Indicated Virus for Indicated No. of Days: Type 1: 5-8	10-11	≥14	Total % Excreting	Type 3: 5-8	10-11	≥14	Total % Excreting
≤32	18	5	7	4	89	3	3	0	0	100	0	0	3	100
45-360	41	8	11	14	81	15	4	3	0	47	3	4	8	100
≥512	19	1	2	6	47	7	0	0	1	14	0	2	1	43
All	80†	14	21	25	75	25	7	3	1	44	3	6	12	84

* Reciprocal of titer against Type 1 virus.
† Includes two infants, with 10 and 14 days excretion, for whom no maternal NA titers are available.

of the appropriate pools. Plaque counts of the diluted pools were made by Dr. James Nakano in December, 1960 (and again in August, 1961, without substantial change), with the following results: Type 1—5.3 x 10^5 (basic) and 5.5 x 10^6 (10X), Type 2—2.8 x 10^5, Type 3—2.6 x 10^5 (basic) and 2.7 x 10^6 (10X), per dose.

The first (newborn) dose of vaccine was administered to babies immediately prior to discharge from hospital. They varied in age from 11 through 95 hours old at that time, and the great majority was from two to three days of age. A vial of vaccine was thawed and brought to room temperature, the contents were drawn up into a soft plastic, rubber-bulbed medicine dropper, and the latter was emptied in the infant's mouth by a combination of slow squeezing and the sucking action of the baby. After it was discovered that the babies took vaccine more readily if it were sweetened, a small amount of granulated sugar was dissolved in each vial after thawing.

Doses of vaccine subsequent to the first were administered in the home by appointment.

Specimen Collection and Laboratory Technics

A venous blood specimen was collected from the mother at the time of recruitment on the day of the baby's birth. Since there is no substantial difference in the polio antibody titer of the infant's umbilical cord serum and that of the mother's,[13] the latter was chosen as the more convenient for establishing a baseline for measuring serologic change. A venous blood specimen then was or will be collected from the baby in the home at seven months of age, i.e., one month or two and one-half months after the administration of the last vaccine dose, depending on the immunization schedule used.

Fecal (diaper) specimens were to be collected with reference to each dose of vaccine, as follows:

First dose (Type 1 or Types 1+3)	—days 0, 6, 10, 14
Second dose (Type 1)	—days 0, 3, 6, 14, 21
Third dose (Type 3)	—days 0, 6, 14, 21
Fourth dose (Type 2)	—days 0, 6, 14, 21

Inevitably, some variations around these planned dates did occur.

Fecal samples were prepared into 10 per cent extracts, extracts were centrifuged, antibiotics were added, pH was adjusted to about 7.4, and they were stored at −15° C until tested. Each extract was inoculated in 0.25 ml aliquants into each of four rhesus monkey kidney cell culture tubes, and the latter were periodically examined for

ten days. If no cytopathic effect was seen at that time the specimen was considered negative; if cell sheet appearance was questionable, supernates were pooled and a second passage made. A second such attempt at virus isolation was made with all limiting or unexpectedly negative specimens, and in about 3 per cent a virus was recovered which had been missed. Positive supernates were all tested by tube complement-fixation or neutralization technics using specific poliovirus antiserums in standard typing procedures.

Maternal serums were tested first as a group, and then again with each mother paired with her baby's seven-month serum specimen, as the latter became available. The pH colorimetric test employed was essentially that of Melnick and Opton,[14] with 0.2 ml quantities each of serum dilution, virus suspension, and cell suspension, and three hours incubation of serum-virus mixture at 37° C. Two cups per twofold dilution were used, and titers are expressed as the reciprocal of the dilution producing 50 per cent end point of significant color change.

Clinical Observations

On the occasion of each home visit, for vaccine administration or specimen pickup, the nurse (J. S. R.) examined the baby briefly and discussed with the mother his health since the last visit. Breast feeding practice was recorded in detail, and it was confirmed that Salk vaccine had not been administered.

Results

Virus Excretion Following First Vaccine Dose (10X)

No baby was found to be excreting an enterovirus cytopathic for monkey kidney cells on the day he was fed the first dose of vaccine. The excretion of poliovirus(es) of homologous type followed the neonatal administration of both monovalent Type 1 and divalent Types 1+3 vaccines in a large percentage of babies, but there were important differences relating to the type of vaccine and to the titer of Type 1 neutralizing antibody (NA) present in maternal serum at the time of delivery.

As shown in Table 2, Type 1 virus was found in a much lower percentage of babies who received the divalent vaccine as compared with those who received the monovalent—44 and 75 per cent, respectively. Type 3 virus was recovered from 84 per cent of babies fed divalent vaccine. Ten babies excreted both viruses simultaneously, 11

Table 3—Association Between Breast Feeding and Type 1 Virus Excretion Following Vaccination in the Newborn Period

Maternal Antibody Titer*	Monovalent Type 1 Vaccine				Divalent Types 1+3 Vaccine			
	Formula Feeding		Breast Feeding		Formula Feeding		Breast Feeding	
	No.†	% Excreting	No.	% Excreting	No.	% Excreting	No.	% Excreting
≤32	4/4	100	12/14	86	1/1	100	2/2	100
45-360	12/12	100	22/29	76	3/5	60	4/10	40
≥512	5/7	71	3/12	25	1/3	33	0/4	0
All	21/23	91	39/57‡	68	5/9	56	6/16	38

* Reciprocal of titer against Type 1 virus.
† Numerator=No. excreting; denominator=No. tested.
‡ Includes two infants, both excretors, for whom maternal NA titers are not available.

Table 4—Duration of Virus Excretion Following Second Vaccine Dose (Type 1) in Relation to Duration Following First Dose (Type 1)

Duration* of Excretion after First Dose	Duration* of Excretion after Second Dose					
	0	3	5-8	13-14	≥21	All
0	8	1	2	3	6	20
5-8	12					12
10-11†	19		1		1	22
≥14	20		3	1	2	26
All†	59	1	6	4	9	80

* In days.
† One "drop-out" before second dose.

excreted only Type 3, one excreted only Type 1, and three failed to excrete either. Note that the excretion of Type 3 was usually of longer duration than that of Type 1 when both had been fed, and that excretion of the latter type usually extended over a greater period of days when it was fed alone than when it was fed in combination with poliovirus 3.

The association between infection, as indicated by virus excretion, and maternal NA titer is also indicated in Table 2. The percentage of babies excreting Type 1 virus declined as Type 1 NA titers increased, from a maximum of 89 per cent among those with the lowest maternal titers to 47 per cent among those with the highest. The excretion of poliovirus 1 by newborns fed divalent vaccine followed the same pattern, and the inverse relationship between titer and percentage of excretors may be even more pronounced. The apparent association between Type 1 antibody level and Type 3 virus excretion may be an artifact of small numbers, or, more likely, high titer of Type 1 NA may imply the greater likelihood of a high titer of Type 3 NA as a result of Salk vaccination. It is noteworthy that among infants who did become infected with Type 1, there appeared to be no constant relationship between antibody level and duration of excretion; prolonged excretion was found in many babies born of mothers with the highest titers.

Histories of feeding practice were collected on each baby, and it was possible to relate the likelihood of Type 1 virus excretion to breast vs artificial formula feeding. Table 3 shows the marked differences found. Ninety-one per cent of 23 babies who received monovalent vaccine and who were formula fed excreted virus for at least five days and the two who did not were both infants with mothers having NA titers of ≥1:2,048. In contrast, only 68 per cent of 57 babies who were breast fed became virus excretors, and there was a decline from 86 per cent among those with the lowest maternal titers to 25 per cent among those with the highest. Type 1 virus excretion was less frequently detected among the smaller number of infants fed divalent vaccine, and the difference between formula-fed and breast-fed infants, 56 and 38 per cent, respectively, was in the same direction.

An attempt was made to learn whether there was less virus excretion when the infants were breast fed just before vaccine administration as compared with those who were first fed at breast after this time; there was uneven

distribution of the small number of babies with high NA titers, and no conclusion could be drawn. Also, there was no demonstrable difference in the percentage of excretors between those who were fed exclusively on breast milk and those who were breast fed only part of the time.

Virus Excretion Following the Second Dose (Type 1)

Virus excretion was usually not detected after the second vaccine dose (given at either six weeks or three months of age), but it did occur and was occasionally of very long duration. It was markedly affected by the type of vaccine used for the first dose, by the duration of excretion after the first dose, and to some extent by the age of the baby when he was "fed" vaccine a second time.

Table 4 shows the correlation between the duration of excretion following the first and second doses when the former was monovalent Type 1. It is apparent that any excretion after the first dose was usually followed by no detectable excretion after the second, this result occurring in 51 of 59, or 86 per cent. However, even after excretion lasting two weeks or longer following the first dose, indicating the rather definite establishment of an active infection, refeeding was occasionally followed by a second period of excretion lasting several weeks. When there had been no detectable excretion following neonatal vaccine feeding, the second dose resulted in excretion that lasted from less than three days to over three weeks. In the absence of supplementary serological evidence, these results are difficult to interpret in terms of the immunizing effect of the first dose. Obviously, both the first and second doses could have failed to cause infection in those instances where no virus excretion was detected. In view of experience gained from past studies, however, it is probable that at an age older than one month a few days of excretion or none at all usually indicates a resistant intestinal tract as the result of prior exposure to homologous virus. It is, therefore, reasonable to summarize the data in Table 4 as follows: (1) 60 of 80 infants (75 per cent) were certainly infected by Type 1 following the first vaccine dose, and some of the 20 others were probably infected by that dose, and (2) 71 of 79 infants (90 per cent) were certainly infected by Type 1 following the series of two doses, and some of the eight others were probably infected by that series of doses.

Table 5—Duration of Virus Excretion Following Second Vaccine Dose (Type 1) in Relation to Duration of Type 1 Excretion Following First Dose (Types 1+3)

Duration* of Excretion after First Dose	Duration* of Excretion after Second Dose					
	0	3	5-8	13-14	≥21	All
0††	2	1	2	3	4	14
5-8†	3		1		2	7
10-11	1				1	2
≥14	1		1			2
All†††	7	1	4	3	7	25

* In days.
† Each † indicates one "drop-out" before second dose.

Table 6—Virus Excretion Following Second Vaccine Dose (Type 1) in Relation to Interval Between Second and First Dose (Type 1)

Excretion after First Dose	Excretion after Second Dose with Interval:			
	6 Weeks		3 Months	
	No	Yes	No	Yes
No	7	5*	1	7†
Yes	39	4‡	12	4§

* 3, 6, 21, 21, 21 days duration.
† 6, 14, 14, 14, 21, 21, 21 days duration.
‡ 6, 21, 21, 21 days duration.
§ 6, 6, 6, 14 days duration.

Twenty-five newborns received the divalent mixture of Types 1 and 3. As seen in Table 5, of these only 11 excreted Type 1 virus in detectable amounts. Of those who did not, 12 were "challenged" by a second dose of Type 1 only, and all but two then excreted homologous virus, seven for two weeks or longer. Following the same reasoning as used above: (1) 11 of 25 (44 per cent) were certainly infected by Type 1 when fed the divalent vaccine in the newborn period, and some of the 14 others were probably infected by that dose, and (2) 20 of 22 (91 per cent) were certainly infected by Type 1 following the series of two doses, and one or both of the two others were probably infected by that series of two doses.

Among the 79 fed monovalent Type 1 as newborns who were later refed Type 1, 55 received the second dose at six weeks of age and 24 received it at three months. These two groups are compared in Table 6 in terms of excretion following both doses. The numbers of infants are small, but there is a suggestion that refeeding at three months was more successful in infecting infants who did not excrete virus following the first dose and in reinfecting those who did.

Type 1 Antibody Response Following Two Doses of Vaccine

Neutralizing antibody determinations were made on the serum pairs consisting of the mother's blood collected at time of delivery and the infant's at seven months of age, the latter being either four or five and one-half months after the last dose of Type 1 vaccine. Unfortunately, at the time of this writing, serum pairs were available from only 59 infants and tentative interpretations will have to be extrapolated to the whole group on the assumption that these results are representative.

Since the infant's serums were collected so long after birth and since NA titers were usually very high (v.i.), little difficulty in interpretation was caused by residual, passive, maternally derived antibody. However, the criteria used for deciding whether active NA formation had occurred included the assumption of one month as the half-life of passive antibody[13] and the requirement that the titer found must be at least 1:8 and eightfold higher than that anticipated from the decline of passive NA at birth.

Of the first 59 babies studied, 56 had significant levels of Type 1 antibody indicative of active immunization. Six infants of the group which had failed to excrete Type 1 virus following two doses of vaccine were included among those tested, and the three failures were all babies in this group. Thus, any detected excretion was associated with active antibody formation. This followed, of course, two doses of vaccine containing Type 1 and it is not possible to separate the effects of the two. However, it was strikingly evident that the NA titers were often much higher (50 per cent $\geq$1:1,024) than those usually found in infants after a single dose of Type 1 vaccine when the same serologic technics were employed in other studies.[7,10] This suggests that many of

these very high titers reflected the booster response to reinfection, although this conclusion cannot be drawn in any individual instance. Very high titers were often found in children who had not excreted virus following either dose. Some interesting examples are shown in Table 7. The first baby is from the previous New Orleans study,[7] and illustrates the typical virologic and serologic result of a single dose of Type 1 Sabin vaccine. The second baby, number 6, demonstrates unquestionable infection following the first dose, an immune excretion response to the second, and a high NA titer. The next baby, number 8, illustrates the failure to recover virus after both vaccine feedings, yet shows successful immunization by his high titer. The fourth baby, number 1, shows only the common finding of two short bursts of virus excretion, and good NA development. The next three babies received divalent vaccine as newborns. Number 12 had a short period of Type 1 excretion after the first dose, none after the second, but is serologically immune. Number 13 demonstrated no Type 1 excretion following the divalent dose (perhaps masked by Type 3 excretion), a suspiciously immune response to the second dose, and ends with an extraordinarily good NA titer. The last baby, number 26, suggests the failure of the first dose of Type 1 because the second was followed by 56 days of excretion, and he had the moderate titer usually found after a first infection.

Clinical Observations

The usual, minor infantile disturbances were noted; no CNS or other illness of consequence occurred. No temporal association between minor illness and vaccine administration could be demonstrated.

Discussion

Although some authors working with other vaccine strains have not noted an association between passive, maternally derived antibody and virus excretion among orally vaccinated newborns,[9,11] both Lepow, et al.,[10] and Sabin, et al. (personal communication of continued study of investigation reported by Krugman, et al.[8]) have found very appreciable differences in the percentage of newborns excreting Type 1 virus

Table 7—Virus Excretion and Antibody Titers in Selected Babies to Illustrate Variations in Response to Two Doses of Vaccine

Baby No.	Type(s) Fed First Dose	Duration* of Excretion, First Dose		Age Fed Second Dose	Duration* of Type 1 Excretion, Second Dose	Type 1 Antibody Titer†	
		Type 1	Type 3			Maternal	At 7 Mo
New Orleans	1	10	—	—	—	32	128
6	1	46	—	6 wk	0	180	>1,024
8	1	0	—	6 wk	0	360	720
1	1	10	—	3 mo	6	2,880	1,024
12	1 and 3	6	≥14	6 wk	0	16	>1,024
13	1 and 3	0	≥14	3 mo	0	2,880	>4,096
26	1 and 3	0	≥14	3 mo	56	360	180

* In days.
† Reciprocal of 50 per cent end point.

after administration of the Sabin strain in relation to maternal NA titer. Furthermore, Lepow, et al.,[10] found that the adverse association with high maternal antibody titer was related in large part to the use of breast milk. These workers found poliovirus neutralizing substances in approximately the same titer in breast milk as in serum of the same women (personal communication). The results of the present study conform to the observations of Lepow, et al., and Sabin, et al. We found that the percentage of virus excretors was lower in infants born of mothers with high antibody levels and that the infants who had been breast fed had the lower percentages of excretion at each antibody level. However, prolonged excretion did sometimes supervene even among infants who had been fed at breast by mothers with the highest titers. The mechanism of the effect of milk with high neutralizing titer may be to prevent primary implantation of vaccine virus, to inhibit local spread and reimplantation of virus, or only to depress virus titer in the feces, thereby reducing the likelihood of isolation. The mechanism of the damping effect of passive humoral antibody alone is less obvious, but, as shown by Bodian and Nathanson in chimpanzees,[15] here also infection and the duration of excretion may not be affected although the titer of fecal virus may be reduced. Our present results, showing the frequent failure of revaccination to result in more than abortive infection, suggest that some newborns who do not excrete virus following vaccine administration or who do so for a very short time have in fact been "immunized" in so far as local intestinal resistance is concerned. Furthermore, the serological results obtained to date indicate that some of these babies have been affected in some manner such that they respond to a second exposure to homotypic oral vaccine with the production of very high antibody titers suggestive of booster reactions. This is similar to the observation by Sabin, et al. (personal communication), that newborns who do not satisfy the criteria for primary infection nevertheless may respond to Salk vaccine inoculation with unusually high Type 1 NA titers.

The use of a divalent mixture of Types 1 and 3 was attempted because of the obvious additional benefit if dual infection were to be induced. Previous study[7,8] had indicated that a trivalent vaccine containing all 3 types was unsatisfactory because of the overgrowth of Type 2, but there was suggestive evidence[7] that Type 1 was more infectious in newborns than Type 3. Our present results showed conclusively, however, that Type 3 is dominant in the mixture and that Type 1 multiplication and excretion is depressed. The advantage of Type 3 immunization is probably not a sufficient compensation for the loss of a substantial percentage of Type 1 vaccine "takes."

There was suggestive evidence for some advantage associated with starting the basic schedule of immunization at three months rather than at six weeks of age as tentatively recommended. However, this is not a definitive observation, and so far the serologic tests of blood specimens collected at seven months of age do not support a conclusion that a superior result is attained. The somewhat greater percentage of fecal virus excretion induced by the later administration of vaccine may be related to a continuing decline in passive antibody levels.

Summary and Conclusions

Probably over 75 per cent of 80 infants "fed" the recommended 10X dose of Sabin vaccine Type 1 within the first few days of life were immunized, as evidenced by subsequent virus excretion and later response to homotypic chal-

lenge. This result was attained despite the fact that these babies were born to mothers of a lower economic group in whom there was presumably high natural poliovirus immunity, sometimes reinforced by Salk vaccination, and among whom breast feeding is common. High maternal NA titer and breast feeding were both shown to be associated with a depression of fecal virus excretion in the infants. It is therefore probable that an equally good result can be anticipated among most population groups in the United States. Seventy-five per cent effectiveness would appear to be sufficient to justify universal newborn vaccination since it is a simple procedure which has never been shown to be unsafe, and because newborn infants in the United States constitute the most readily accessible age group prior to school age. Furthermore, the problem of natural enteroviral interference with the vaccine strains is obviated at this age. Newborn vaccination, however, must be considered to be an addition to the regular schedule recommended during the first year of life, and cannot be used as a substitute for later vaccination.

Divalent vaccine, consisting of Types 1 and 3, produced Type 1 immunization in probably over 44 per cent of 25 newborns to whom it was administered. This is a higher percentage than was attained by the use of trivalent vaccine, but it is still too low and divalent vaccine, of the type used in this study, cannot be recommended.

The basic schedule of poliomyelitis immunization was started with Type 1 Sabin vaccine in recommended dose at six weeks of age in 63 infants and at three months of age in 38. Virus excretion following this second dose was not detected in the majority, presumably because of the resistant state of the intestinal tract as a result of the previous exposure. Reinfection was demonstrated in some, particularly in those who had failed to excrete virus following neonatal vaccination. So far, there is little evidence that vaccine feeding is any better at three months than at six weeks. Probably about 95 per cent of the 101 infants who received both doses of vaccine were immunized against Type 1, as indicated by virus excretion and incomplete serologic study. It is very likely that many of the remaining 5 per cent will be immunized against this type upon receiving the trivalent "cleanup" dose at about one year of age.

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Dr. Holguin is epidemiologist; Miss Reeves is nurse-epidemiologist; and Dr. Gelfand is chief; Enterovirus Unit, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Atlanta, Ga.

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On the Reunification of Knowledge

"All sciences, all arts, all practical activities, all University subjects, are products of Man's mind and body. They must all ultimately have a common basis, and must ultimately have a common language. The more that we understand each other's intellectual techniques, the more easily shall we understand each other's thoughts, and the more easily shall we bridge the chasms between our groups. Whilst on a short-term view our mathematicians may be better if their time is not wasted learning irregular verbs, and whilst our linguists may make quicker progress if they haven't had the bother of maths and science, on the long-term view we shall slow down the progress of all our studies by being narrow specialists. More and more the sciences of Man will become central and the 'scientist of Man' will have to concern himself with a variety of subjects and approaches; each one of us needs a greater, not a smaller variety of techniques at his disposal."

(From the Report of a Discussion in the Senate House at Cambridge University, England, contributed by Dr. C. H. Wright, in "Reporter," March 4, 1959. From "Science in Writing," p. 13, by T. R. Henn, Macmillan, New York, 1961.)