

IMMUNITY TO POLIOMYELITIS IN MOTHERS AND THE
NEWBORN AS SHOWN BY THE NEUTRALIZATION
TEST*

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Evidence has been presented elsewhere relating to the age distribution of poliomyelitis which indicates that immunity to the disease is widespread, bearing a direct relationship to age and concentration of population and an inverse relationship to the incidence of the disease in all age groups.† It was inferred from this study that the virus of the disease has a similar widespread distribution (1). Neutralization tests on a series of individuals not giving a history of poliomyelitis were reported in a later communication (2). In an urban population im-

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† While increasing immunity with increase in age is undoubtedly a major factor in determining the diminishing incidence of the disease with increase in age, there are indications that especially after adult age is reached a diminishing chance of adequate exposure is also a factor not only in the diminishing incidence of the disease but also in a diminution in the rate with which immunization occurs with increase in age. Diminishing chances of contact infection with age are also suggested by Chapin's figures for measles, which show a diminishing attack rate in susceptibles in families with cases with increase in age (5), as well as by Pope's studies of scarlet fever (6). The idea of diminishing chance of exposure with increase in age is also in line with certain indications that in adults there tends to be a loss of immunity which might be accounted for by lack of reinforcement from repeated exposures. For rural populations both our own neutralization tests for immunity to poliomyelitis and Kidder's figures for immunity to diphtheria (7) indicate a slightly higher susceptibility amongst adults in general than for the 15 to 19 year age group.

munity was found to exist least often in the 1 to 5 year age group, but with increasing frequency with increase in age. In a rural population not only was the frequency of immunity in the 1 to 5 year age group less but the increase in the frequency with which it was found with increase in age was less than in the urban population. Evidence has also been presented that urban adults residing in a warm climate enjoy a degree of immunity to the disease similar to that of urban adults living in a cool climate (3). This suggests a similar widespread distribution of the virus in warm and cool climates, and in view of the greatly diminished incidence of the disease in warm climates, emphasizes the point brought out elsewhere that the occurrence of the disease may not in all circumstances parallel the distribution of the virus (4).

The results of these studies of the extent of immunity in relation to the incidence of the disease with respect to age and concentration of population when compared with similar studies on diphtheria suggest that the mechanism of dissemination of the virus and of immunization is the same as in diphtheria, the essential difference in the epidemiology of the two diseases lying in the frequency with which the "accident" of disease occurs in the process of immunization.

In infants under 1 year of age the incidence of both poliomyelitis and diphtheria is low. In the case of diphtheria the relatively low incidence in the first year of life has been shown to be due to an immunity passively derived from the mother. This passive immunity disappears in most instances before the age of 1 year is reached. Polano (8) in 1904 in testing the blood of seven mothers and the cord blood from their infants found that the amount of antitoxin was quantitatively similar or was absent in each. Von Groer and Kassowitz (8) testing mothers and infants at 143 births found antitoxin in 84 per cent of infants. In 96 per cent of these, mothers and infants corresponded with one another in having or not having antitoxin. Zingher, (8) in 1917, working with the Schick test upon 23 mothers and infants up to 3 months of age, found only a single divergent result, namely, a positive test (no antitoxin) in an infant from a Schick negative mother.

In order to determine whether the relatively low incidence of poliomyelitis in infants is similarly due to temporary maternal passive immunity we have tested the blood sera of a group of mothers together with sera from the cord blood of their newborn infants for the presence of neutralizing substance for the virus of poliomyelitis. The

sera were mixed with a virus suspension, incubated for 2 hours, placed in the ice box over night, and inoculated intracerebrally into *rhesus* monkeys in the manner described in our earlier papers (2, 3). The results of these tests are shown in Table I.

The serum of nine mothers and their infants completely neutralized the virus. The serum of one infant neutralized the virus while the animal inoculated with the mixture of virus and the mother's serum developed the disease on the seventeenth day following inoculation. The control animal in the same experiment developed the disease on the eighth day.* The serum of two mothers and their infants failed to neutralize the virus.

These results may be taken as an indication that where the mother is immune to poliomyelitis there is a passive transmission of immunity to the infant. We have not performed any tests to determine the duration of this immunity or whether or not it is fortified or prolonged by suckling, as has been shown to be the case in diphtheria. However, previous tests showing immunity in a relatively low proportion of children in the 1 to 5 year age group together with the relatively high incidence of the disease in this age group suggest that the duration of passive immunity in infants is not unlike that in diphtheria.

DISCUSSION

In this small series of tests immunity was found in a correspondingly high percentage of infants at birth and their mothers, the infants corresponding in each instance with the mother in respect to immunity with one exception, in which the result was doubtful but not contradictory. The fact that even in this small series the findings agree with what was anticipated from an analysis of the age distribution of poliomyelitis in comparison with that of diphtheria justifies the conclusion that the relative infrequency of poliomyelitis under one year of age is due in considerable measure to a passive transmission of immune bodies to the young through the placenta. No tests have been done to determine whether this passive immunity receives reinforcement

* While the result of this test is doubtful, from our previous experiments we have come to regard an incubation period of more than 14 days (using an active 7 or 8 day virus) as probably representing partial neutralization, *i.e.*, a degree of immunity.

TABLE I

Neutralization of the Virus of Poliomyelitis by Serum of Mothers and Newborn Infants

Case	Monkey	Virus No.	Virus-serum mixture 1:1 cc.	Date of inoculation	Outcome	Neutralization	Remarks
44780 (mother) 21 yrs.	49-8	515	1.0	4/ 8/30	No symptoms	+*	
44780 (baby)	48-9	515	1.0	4/ 8/30	No symptoms	+	
44798 (mother) 17 yrs.	47-6	515	1.0	4/ 8/30	No symptoms	+	
44798 (baby)	47-0	515	1.0	4/ 8/30	No symptoms	+	
44799 (mother) 19 yrs.	39-8	515	1.0	4/ 8/30	4/19 Paralyzed	-	Recovered with residual paralysis
44799 (baby)	49-5	515	1.0	4/ 8/30	4/21 Paralyzed	-	Typical microscopic lesions of poliomyelitis†
Convalescent serum No. 83	49-2	515	1.0	4/ 8/30	No symptoms	+	
Normal monkey serum	47-4	515	1.0	4/ 8/30	4/16 Paralyzed	-	Typical microscopic lesions of poliomyelitis
44803 (mother) 22 yrs.	49-9	515	1.2	4/10/30	4/17 Paralyzed	-	Typical microscopic lesions of poliomyelitis
44803 (baby)	34-5	515	1.2	4/10/30	4/18 Paralyzed	-	Typical microscopic lesions of poliomyelitis

* In the seventh column of the table *plus* indicates that the serum did neutralize the virus and *minus* that the serum failed to neutralize. *Plus and minus* indicates a doubtful or partial neutralization.

† Where *Typical microscopic lesions of poliomyelitis* appears under *Remarks*, the animals were etherized and an autopsy performed. The statement applies to examination of sections of spinal cord.

TABLE I—*Continued*

Case	Monkey	Virus No.	Virus-serum mixture 1:1	Date of inoculation	Outcome	Neutralization	Remarks
44773 (mother) 19 yrs.	51-1	515	1.2	4/10/30	No symptoms	+	
44773 (baby)	30-1	515	1.2	4/10/30	No symptoms	+	
44831 (mother) 24 yrs.	38-3	515	1.2	4/10/30	No symptoms	+	
44831 (baby)	33-2	515	1.2	4/10/30	No symptoms	+	
Convalescent serum No. 83	54-3	515	1.2	4/10/30	No symptoms	+	
Normal monkey serum	34-6	515	1.2	4/10/30	4/18 Paralyzed	—	Typical microscopic lesions of poliomyelitis
44844 (mother) 26 yrs.	54-4	515	1.2	4/22/30	No symptoms	+	
44844 (baby)	54-5	515	1.2	4/22/30	No symptoms	+	
44830 (mother) 35 yrs.	54-6	515	1.2	4/22/30	No symptoms	+	
44830 (baby)	54-7	515	1.2	4/22/30	No symptoms	+	
44845 (mother) 21 yrs.	54-8	515	1.2	4/22/30	No symptoms	+	
44845 (baby)	54-9	515	1.2	4/22/30	No symptoms	+	
Convalescent serum No. 83	55-0	515	1.2	4/22/30	No symptoms	+	

TABLE I—*Concluded*

Case	Monkey	Virus No.	Virus-serum mixture 1:1 cc.	Date of inoculation	Outcome	Neutralization	Remarks
Normal monkey serum	55-1	515	1.2	4/22/30	4/28 Paralyzed	—	Typical microscopic lesions of poliomyelitis
44860 (mother) 22 yrs.	47-0	515	1.2	5/ 8/30	No symptoms	+	
44860 (baby)	47-6	515	1.2	5/ 8/30	No symptoms	+	
44849 (mother) 23 yrs.	53-8	515	1.2	5/ 8/30	No symptoms	+	
44849 (baby)	49-8	515	1.2	5/ 8/30	No symptoms	+	
44856 (mother) 22 yrs.	49-6	515	1.2	5/ 8/30	5/25 Paralyzed	±	Typical microscopic lesions of poliomyelitis
44856 (baby)	53-6	515	1.2	5/ 8/30	No symptoms	+	
Convalescent serum No. 83	50-8	515	1.2	5/ 8/30	No symptoms	+	
Normal monkey serum	47-3	515	1.2	5/ 8/30	5/16 Paralyzed	—	Typical microscopic lesions of poliomyelitis

through transmission from the milk in suckling, nor has the duration of passive maternal immunization been determined. But the fact that eleven out of fifteen (73.5 per cent) children from 9 months to 5 years of age failed to neutralize the virus (2) (two of them were 9 months and 11 months old respectively) together with the fact that as in the case of diphtheria the incidence rises sharply after 6 months of age, suggests the probability that the mechanism of maternal immunization to poliomyelitis is similar to that of diphtheria.

At this point we may discuss briefly the results of these and previous tests for immunity to poliomyelitis from the point of view of their statistical significance. The tests performed on individuals of any one category is small—too small, as we have repeatedly pointed out, to establish the point in question when taken alone. But even where samples are small, if we observe several such samples and find them consistent with each other and with other comparable observations, the statistical significance of such observations rises rapidly.

In the first place, as discussed in detail in our earlier communications regarding the neutralization test, the test may be considered as a reliable indication of immunity.

The idea that the majority of urban adults have become immunized to the virus of poliomyelitis, upon which our present conception of the

TABLE II
Summary of Neutralization Tests for Virus of Poliomyelitis—Urban Adults

	Immune	Per cent	Not immune	Per cent
Northern adults.....	7	85.7	1	14.3
Southern adults.....	19	90.5	2	9.5
Northern mothers.....	10	83.3	2	16.7
Total urban adults.....	36	87.8	5	12.2

epidemiology of the disease hinges, is not only supported by tests which show immunity in increasing frequency up to adult age but by three separate sets of tests on urban adults themselves, all of which, as shown in Table II, are in close agreement.

The curves for immunity in normal individuals at different age groups both in urban and in rural populations have a similar trend. The diminished extent of immunity in a rural population is in accordance with diminishing chances of contact transmission of the virus, due to decrease in density of population.

The extent of immunity at different ages and in urban and rural populations, as well as in mothers and infants, is in accord with what might be expected from an analysis of the age distribution of the disease.

Finally, the extent of immunity to poliomyelitis in each age group

tested corresponds closely with that of immunity to diphtheria. This with other evidence that the process of immunization is essentially the same for the two diseases is regarded as additional support for the statistical validity of the relatively small number of observations which have been made on poliomyelitis.

SUMMARY

Neutralization tests for the virus of poliomyelitis on blood serum of urban mothers and their newborn infants showed that immunity was present in ten out of twelve (83 per cent) infants and in ten out of twelve (83 per cent) mothers, with a complete correspondence between mother and infant. These tests point to passive transmission of immunity from mother to infant. Previous tests on other children (1 to 5 years) indicate that immunity in infants is transitory. Previous observations concerning the extent of immunity in urban adults are confirmed and extended. The results of these tests are in accord with the age distribution of poliomyelitis and parallel corresponding observations in diphtheria.

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