SEROIMMUNITY OF NATIONAL SERVICEMEN IN SINGAPORE TO POLIOMYELITIS

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SYNOPSIS

A national immunisation programme to control poliomyelitis in Singapore was introduced in 1962. Its implementation has given rise to a birth cohort of persons born in 1955 - 1958 who missed the programme and could constitute a group susceptible to poliomyelitis.

A study of the seroimmunity of 127 men in this cohort was carried out. National servicemen in the Singapore Armed Forces were chosen as subjects. It was found that 35.4% of them showed susceptibility to poliomyelitis infection.

The selection of the subjects for the study was discussed and it was postulated that they could give a good indication of the immunity levels of other national servicemen in the same age cohort.

It was pointed out that the relatively high concentration of this age cohort in an army environment would increase the risk of disease transmission and that these susceptibles be immunised against poliomyelitis as a precautionary measure.

INTRODUCTION

Poliomyelitis was a major public health problem in Singapore during the immediate post-war years. It presented as an endemic disease with sporadic epidemics. The largest epidemic occurred in 1958 when 415 paralytic cases were notified (1).

In 1962 a national poliomyelitis immunisation programme was introduced to control the disease. It was based upon the use of an oral vaccine and was directed primarily at young children as they formed the most susceptible group in the community. As the programme developed, a more systematic and thorough coverage of infants, pre-school and schoolchildren was achieved. No provision, however, was made for the immunisation of the older age-groups in the population.

This programme contributed largely to the drop of the prevalence of the disease. In the last decade, from 1970 to 1979, only four cases were reported and in seven of these ten years, no cases were reported in the country. With the continuation and maintenance of this programme at a high coverage, it is unlikely that future outbreaks of paralytic poliomyelitis will occur among the younger population in the country.

The virtual absence of paralytic cases of poliomyelitis does not, unfortunately, indicate that disease transmission has been interrupted. Nor does it imply that future outbreaks of the disease will not occur, even with the continuation of the present programme. With the disease no longer prevalent, it would be difficult for those not immunised to acquire immunity by natural means. Such people would form a group who would be largely susceptible to poliomyelitis.

Who are these people? What would their risk of acquiring poliomyelitis be like? Can something be done to minimise these risks? Is there a possibility that the epidemiological pattern of poliomyelitis in Singapore will change from 'infantile' to an 'adult' form? These are some of the questions that need to be answered in today's context.

As a first step to find answers to some of these questions, a small study was undertaken to evaluate the seroimmunity of national servicemen in the Singapore Armed Forces to poliomyelitis. This paper presents the findings of this study, discusses their implications and suggests ways to remedy some of the deficiencies noted.

METHOD

The study population consisted of the first thirty-five national servicemen, in each of the age-groups 18, 19, 20 and 21 years, who attended the Singapore Armed Forces Changi Hospital Outpatient Clinic during a period of one month.

Blood samples were collected by venipuncture. The sera were separated and stored frozen. Before the test, the sera were thawed and inactivated at 56°C for half an hour. A one-in-three dilution of each serum was then prepared for the detection of poliovirus neutralising antibodies. Aliquots of this serum were mixed with equal volumes of each of the three types of poliovirus, using a challenge dose of 100-300 $TCID_{50}$ of the virus. The mixture was incubated in a water-bath at 37°C for two hours and then inoculated into three tubes of primary monkey kidney culture. The inoculated cultures were placed in a roller drum and incubated at 37°C. Virus and cell culture controls were included in the test. Reading of the test was done daily. A serum was regarded as 'positive' (showing neutralising antibodies to the poliovirus) if there was inhibition of cytopathogenicity in at least two of the three test cultures at the end of four days.

RESULTS

All the 127 male national servicemen in this study presented with minor illnesses for which they sought medical aid at the Outpatient Clinic. None had signs or symptoms of paralytic poliomyelitis.

The distribution of subjects in the different age-groups was almost equal except for a smaller number in the 21 year age-group (Table 1).

The sera of all 127 national servicemen were tested for neutralising antibodies to the different poliovirus. Antibodies to all three types of poliovirus were found in the sera of 82 (64.6%) national servicemen, indicating that they should be immune to poliomyelitis (Table 1).

Table 1
Distribution of national servicemen by their immune status to poliovirus and age groups

Age (in years)	Immune to all 3 types of poliovirus	Susceptible to poliovirus		Total
		1 type	2 types	
18	24	9	2	35
19	23	11	1	35
20	23	10	1	34
21	12	8	3	23
Total	82	38	7	127

Of the remaining 45 national servicemen, 38 (29.9%) were susceptible to poliovirus infection by one poliovirus type and 7 (5.5%) lacked antibodies to two types of poliovirus. None was susceptible to infection by all three types of poliovirus. There was no significant difference in the proportion of susceptibles in the different age-groups.

Susceptibility to infection varied with the serotype of poliovirus. In this study 27 (21.3%) national servicemen were found to be susceptible to infection by Type 3 poliovirus, while susceptibility to infection by Types 2 and 1 poliovirus was noted in 16 (12.6%) and 9 (7.1%) national servicemen respectively (Table 2).

Table 2
Distribution of susceptible national servicemen to poliomyelitis by the different types of poliovirus

Poliovirus Type	Susceptible subjects	
	No	%
Type 1 only	4	8.9
Type 2 only	13	28.9
Type 3 only	21	46.7
Type 1 and 2	1	2.2
Type 1 and 3	4	8.9
Type 2 and 3	2	4.4
Total	45	100.0

This variation could be related to the frequency of exposure of the study cohort during early childhood and to the various poliovirus circulating in the community. Poliovirus Type 1, which accounted for 80% of the paralytic cases in Singapore, was freely circulating then (2). Exposure of this cohort could therefore be expected to be high resulting in the relatively high immunity to Type 1 poliovirus that was noted.

It was also possible that exposure to oral poliovaccine could have caused this variation. However, it could not be ascertained whether or not any of the subjects had previously received poliovaccine, even though they were closely questioned and a search was made for documentary evidence of immunisation.

DISCUSSION

This study was aimed at determining the level of seroimmunity to poliomyelitis in a population group believed to have relatively high susceptibility to infection. Singapore citizens born between 1955 and 1958 (18-21 years in 1976) would form such a group as they were neither exposed to the full immunisation programme nor were they able to acquire natural immunity because of the rapid decline of the disease in the community. The country's present and future young populations will, with the continuance and

maintenance of the current immunisation programme, be assured of adequate protection against poliomyelitis. The older generations, who have been exposed to an era when poliomyelitis was rife, would also be adequately protected through naturally acquired immunity. Those in the age-group 18-21 years in 1976 were, thus, considered the most critical and relevant segment of the population. It was, therefore, decided to make a study of this age-group in the first instance.

National servicemen serving full-time in the Singapore Armed Forces were chosen as subjects. As the majority of male Singapore citizens (from 18-21 years of age) serve in the armed forces, they form a suitable and convenient source. It might be argued that the sample was biased as the subjects were not normal and healthy but were suffering from illnesses (minor though these might be) and thus would not be representative of others in the service. On the other hand, there was no reason to suspect that their immunity to poliomyelitis would differ markedly from other national servicemen. The minor illnesses which prompted them to seek medical aid would not alter their immune status to poliomyelitis. If there was any bias, then it would be likely to act in favour of producing a higher level of immunity among this group, on the assumption that they would be having subclinical or non-paralytic poliomyelitis when the specimen was taken.

It would, of course, be preferable to select a random sample from the entire national service intake. The sampling frame from which such a sample would be selected, would have to include national servicemen in the other uniformed services (e.g. police, vigilante corps, etc.) and those who were either deferred (e.g. for tertiary education etc.) or exempted from national service (e.g. on compassionate grounds etc.). Since a complete listing was not available, we were not able to select a random sample which would be representative of the entire age cohort. Thus for this study the sample selection was limited to national servicemen who were in the armed forces in 1976. Since there was no pre-selection (insofar as poliomyelitis is concerned) of national servicemen to units that had access to the Changi Hospital Outpatient Clinic, it would be reasonable to postulate that the sample chosen would give a good indication of the immunity to poliomyelitis in the specified age-groups among national servicemen in the Singapore Armed Forces in 1976.

Poliomyelitis immunisation was initiated in 1958 during an epidemic caused by Type 1 poliovirus. In an attempt to control the outbreak, a single dose of Type 2 vaccine was given orally to children aged 3 months to 10 years. (1) Four years later, in 1962, the first phase of a national poliomyelitis immunisation programme was introduced. This was limited to infants and pre-school children. The vaccination schedule was modified the following year and extended to primary school entrants (3). Following a review, the programme was extended in 1976 to primary and secondary school leavers in order to enhance and maintain immunity (2) (Table 3).

The selected national servicemen, who were born between 1955 and 1958, missed both the infant and

Table 3
Evolution of the national poliomyelitis programme in Singapore 1958 - 1980

Year introduced	Target Population	Polio vaccine used		Duration of programme
		Type	No. of doses	
1958	Children: 3 months - 10 years	2	1 dose	Discontinued in 1958
1962	Children: 1 year - 5 years	1, 2 & 3	2 doses	Discontinued in 1962
1963	Infants: 3 months - 5 months	1, & 3 1, 2 & 3	2 doses 1 dose	Ongoing
	Pre-school: 18 months - 4 years	1, 2 & 3	2 doses	Ongoing
1964	School Entrants: 6 - 7 years	1 & 3 1, 2 & 3	1 dose 1 dose	Discontinued in 1976
1976	School Entrants: 6 - 7 years	1, & 3 1, 2 & 3 1, 2 & 3	2 doses 1 dose, or 1 dose	Ongoing
	School Leavers: 11 years 15 years	1, 2 & 3 1, 2 & 3	1 dose 1 dose	Ongoing Ongoing

pre-school immunisation programmes. They were too old to be covered by either programme when it was introduced. They also missed the immunisation programme for school leavers as this was introduced in 1976 after they had left school (Table 4).

It is possible that some of the national servicemen received poliovaccine. During the 1958 outbreak, the Type 2 vaccine was offered to children born in the years 1948 to 1959. Since the coverage of the target groups in 1958 was relatively low, only a small proportion of the cohort could have benefited from it. Those born in 1957 and 1958 might have also received some poliovaccine in school as the school programme was introduced in 1964. Unfortunately the initial coverage of school entrants was relatively limited and it is estimated that about half of this age-group would have received the vaccine (Table 5).

Table 5
Percentage distribution of school entrants covered by the school immunisation programme against poliomyelitis from 1964 - 1966

Year	School Population	% given poliovaccine	
		1 Dose	2 Doses
1964	59,084	56.9	49.9
1965	61,931	80.7	72.0
1966	61,222	80.7	77.6

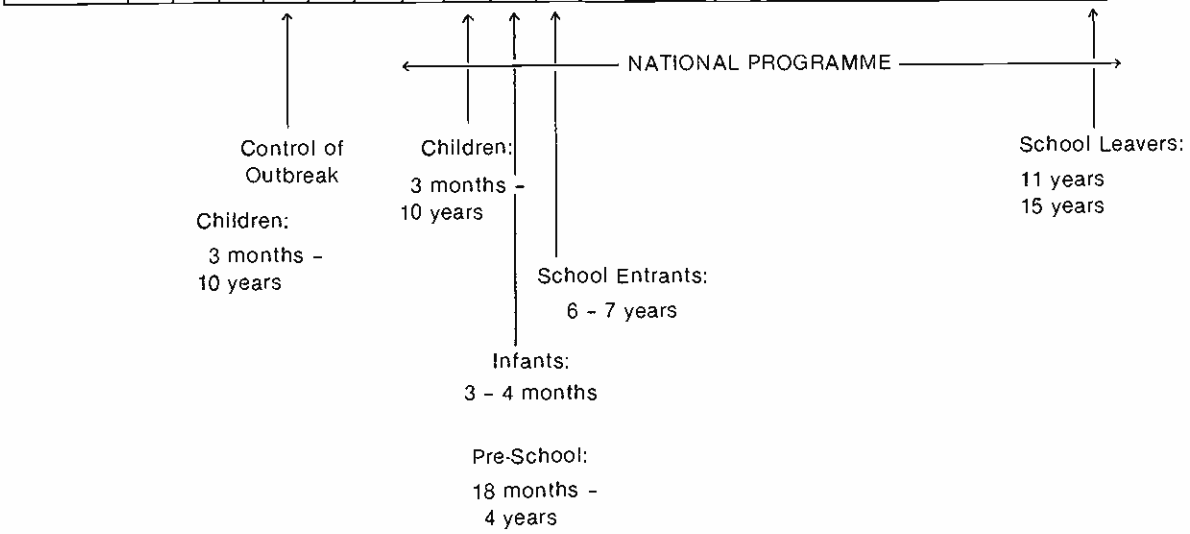
Source: Reports of the Immunisation Programme in the Republic of Singapore, 1964-1966.

The analysis of this age cohort's exposure to poliovaccine, showed that it was inadequately covered by the immunisation programme. The findings of the study further strengthened this view as 35.4% of the sample showed susceptibility to infection.

Studies have suggested that an accepted level of susceptibles in a community is about 30%. A higher level would trigger off an epidemic should the disease agent be introduced into the community. In normal circumstances the 18-21 year age-group (in 1976)

Table 4
Relationship of the national poliomyelitis programme with the 1955 - 1958 cohort

Year of Birth	Age in years from 1955 - 1976 and Programmes introduced																					
	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
1955	<1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1956	—	<1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1957	—	—	<1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1958	—	—	—	<1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18



would not pose a problem as they would be protected by the herd immunity of the community. In the environment of an army camp, however, the epidemiological situation changes radically. There is a high concentration of servicemen of the same age-group within camps and this increases the risk of easier spread of disease. Being a confined group who take most of their meals in the camp, these susceptible national servicemen could form a nidus for an outbreak of poliomyelitis when there is a breakdown of food hygiene and the poliovirus is in circulation.

It is recommended, therefore, that national servicemen in this risk cohort (1955-1958) be immunised against poliomyelitis. It would, probably, not be necessary to immunise the entire age cohort as they would form a high risk group only when they form the majority in a given setting e.g. during national service. It is suggested that oral poliovaccine be used as it is not only effective but also it minimises the administrative, logistical, and financial problems in mounting such a campaign.

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