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Serum antibody to poliovirus in patients in a mental deficiency hospital, with particular reference to Down's syndrome

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SUMMARY

Neutralization tests for poliovirus antibodies were carried out on 74 patients in an adult mental deficiency hospital: 37 patients with Down's syndrome and 37 non-Down's mental defectives. The distribution of antibody titres to poliovirus types 1, 2 and 3 did not differ significantly between the two groups. Most patients had antibody to at least one poliovirus type but less than a third had antibodies at a titre of 1/8 or greater to all three types. The low level of poliovirus immunity in this population may be of epidemiological importance.

INTRODUCTION

Poliomyelitis has become a rare disease in Britain since the introduction of inactivated poliovirus vaccine in 1956 and of oral live attenuated vaccine in 1961. Sporadic cases of the disease still occur and it is essential that herd immunity is maintained to prevent recurrence of epidemics. Unfortunately, immunization against poliomyelitis has recently been declining, the incentive to parents to have their children immunized being reduced by the rarity of the clinical disease.

Distributions of poliovirus antibodies in the community have been surveyed in Britain before and after the introduction of polio vaccination. The pre-vaccine surveys, as summarized by Mortimer & Cunningham (1975), showed considerable variation in immunity throughout the country. After the advent of polio vaccination less striking differences were found between areas but gaps in herd immunity persisted (Reid *et al.* 1973).

The present investigation of polio antibodies in a closed community in an adult mental deficiency hospital was planned because of interest in immunological

mechanisms in Down's syndrome. Both humoral and cellular immune systems show deviation from normal in this condition. Serum immunoglobulin concentrations differ from those of the general population, and in particular show high serum IgG concentrations in adult institutionalized subjects (Adinolfi, Gardner & Martin, 1967). The physical properties of the immune globulins are also atypical, with evidence of a disproportion in the concentrations of the subgroups of IgG (Thom & McKay, 1972). The T cell population in Down's syndrome is smaller than in normal subjects (Levin, Nir & Mogilner, 1975), and the *in vitro* response of circulating lymphocytes to phytohaemagglutinin is reduced (Rigas, Elsasser & Hecht, 1970). Clinically, there is susceptibility to infections, particularly of the respiratory tract, and some authors have found impairment of specific serum antibody responses, although others have found the responses to be within normal limits (Lopez *et al.* 1975).

The aims of the present study were as follows:

(1) To compare serum antibody titres to poliovirus in patients with Down's syndrome with those in other mentally deficient patients in the same institution.

(2) To compare serum antibody titres to poliovirus in patients in a mental deficiency hospital with those reported in previous studies in the general population.

MATERIALS AND METHODS

Study population

The subjects studied were patients resident in a mental deficiency hospital (total population approximately 500). No history of poliovirus vaccination was available in many cases while in others the information was not sufficiently reliable for use in analysis of results.

The 38 physically healthy patients with Down's syndrome who were resident in the hospital were paired with 38 non-Down's mental defectives on the basis of sex, age (within $\pm$ 5 years) and villa of residence. No Down's patients were on phenytoin therapy and non-Down's subjects on phenytoin were excluded because of the known effects of this drug on immunity mechanisms (Sorrell *et al.* 1971). Several patients in both groups were on other anticonvulsants or tranquillizers.

Blood samples were collected from all subjects and the sera were tested for hepatitis Bs antigen by immuno-electro-osmophoresis before storage at -20 °C. A sample from one Down's patient was found to be positive for HBs antigen so this patient and the corresponding control were excluded from the study. This left two groups for study (referred to as the T21 group and the MD group) each comprising 13 females and 24 males with an age range from 18 to 63 years (Table 1).

Neutralization tests

The sera were tested for neutralizing antibody to poliovirus types 1, 2 and 3 using the modified micrometabolic inhibition test (Kyriazopoulou & Bell, 1972) with overnight incubation of serum–virus mixtures at 4 °C. Stock HeLa cell cultures were maintained by the standard methods used in the laboratory. Sera were first screened at a dilution of 1/8 and if antibody was present were then titrated. The Kärber formula was used for determination of 50 % endpoints.

Table 1. *Age in years of study population*

Group	Age (years) Range	Mean	Number in each age group 18–29	30–39	40–49	50+	Total
T21	18–63	36·1	12	11	7	7	37
MD	19–59	36·0	13	12	5	7	37

Table 2. *Patients with and without poliovirus antibody detectable at a titre of* 1/8

Group	Total	Antibody titre	Poliovirus type 1	2	3
T21	37	1/8 or >	28	17	21
		< 1/8	9	20	16
MD	37	1/8 or >	27	24	22
		< 1/8	10	13	15

Table 3. *Neutralizing antibody to poliovirus types* 1, 2 *and* 3

Group	Neutralizing antibody (geometric mean titre) Type 1	Type 2	Type 3
T21	19·8	18·9	26·4
	(28)	(17)	(21)
MD	34·5	24·2	24·9
	(27)	(24)	(22)

Figures in parentheses: number of patients with antibody (1/8 or greater).

RESULTS

Comparison of T21 and MD groups

Comparison of serum antibody titres to poliovirus in the 37 T21 and the 37 MD patients showed no significant difference between the two groups. Three methods of comparison were used:

(i) The three polioviruses were considered separately, dividing patients into those without antibody (titre less than 1/8) and those with antibody (titre 1/8 or greater) (Table 2). For virus types 1 and 3 the proportion of patients with antibodies was almost identical in the T21 and MD groups. For virus type 2, although the proportion (46%) of T21 patients with antibodies was lower than in the MD group (65%) the difference was not significant ($\chi^2 = 2{\cdot}7$, 1 D.F., $P > 0{\cdot}05$).

(ii) Antibody titres were compared in patients with titres of 1/8 or greater and the geometric mean titres are shown in Table 3. The log titres in the T21 and MD groups did not differ at the 5% level of significance for any of the three poliovirus types. For virus types 2 and 3 the mean log titres were almost the same for T21 and MD patients. For virus type 1, MD patients had a 20% higher

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Table 4. *Incidence of poliovirus antibody (titre 1/8 or greater) in two age groups*

Age	Group	Total no.	Number of patients with antibody to Type 1	Type 2	Type 3
18–39	T21	23	23 (100·0)	11 (47·8)	15 (65·2)
	MD	25	18 (72·0)	18 (72·0)	16 (64·0)
40–63	T21	14	5 (35·7)	6 (42·9)	6 (42·9)
	MD	12	9 (75·0)	6 (50·0)	6 (50·0)

Figures in parentheses: percentages of patients with antibody (1/8 or greater).

Table 5. *Frequency of poliovirus neutralizing antibodies (titre 1/8 or greater)*

Group	Total	Patients with antibody to One type	Two types	Three types	At least one type
T21	37	12 (32·4)	12 (32·4)	10 (27·0)	34 (91·9)
MD	37	8 (21·6)	16 (43·2)	11 (29·7)	35 (94·6)
T21+MD	74	20 (27·0)	28 (37·8)	21 (28·4)	69 (93·2)

Figures in parentheses are percentages.

mean of log titres than T21 patients; however, this difference was not general, the higher mean arising from very high values in only six MD patients. There were 19 pairs of patients with both members having antibody levels (type 1) greater than 1/8. A paired t test of these levels was not significant ($t = 1{\cdot}0$, 18 D.F., $P > 0{\cdot}1$).

(iii) The incidence of poliovirus antibody titres of 1/8 or greater in patients below and above 40 years of age is shown in Table 4. All T21 patients aged less than 40 years had antibody to poliovirus type 1 compared with only 36% of patients aged 40 or more; there was no similar difference in the MD group. For antibodies to polioviruses 2 and 3 the relative frequencies of patients were similar in the two patient groups. When the change of log titre with age was studied in the MD patients the changes were negligible for all three polioviruses. For T21 patients, log titres of polioviruses 1 and 3 were negatively correlated with age, but the correlation coefficients were of only borderline significance ($P \sim 0{\cdot}05$). Antibody titres for poliovirus 2 did not change with age.

Combined T21 and MD groups

Since antibody titres for T21 and MD groups did not appear to differ, the two sets of data were combined to derive best estimates for the hospital population.

Over 90% of the 74 patients had poliovirus neutralizing antibody detectable at a titre of 1/8 or greater to at least one type of poliovirus (Table 5). However, only 28% had antibodies at this titre to all three polioviruses and 27% had

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antibody against only one virus type. The observed frequencies of patients with none, one, two or all three types of antibody were essentially identical with those expected if exposure to each virus type occurred independently.

MD group

Study of the case records of the patients in the MD group showed no obvious relationship between the antibody findings and clinical diagnosis or drug therapy.

DISCUSSION

There is a continuing need for monitoring of vaccinated populations for immunity levels and numerous surveys of poliovirus antibodies have been reported. The most relevant studies for comparison are those described by Reid *et al.* (1973), Bell (1974) and Mortimer & Cunningham (1975). A low degree of protection was found in Glasgow preschool children where only 46% of those who had been fully immunized had antibody to all three types (Reid *et al.* 1973). Bell (1974) found antibody to all three types in 89% of 327 sera from adults in the 15–29 year age group, and Mortimer & Cunningham (1975) reported similar findings in 63% of 706 antenatal sera. Our patients showed a lower frequency of serum polio antibodies: less than one third (28%) had antibodies at a titre of 1/8 or greater to all three virus types although the majority (93%) had antibody to at least one type. The inclusion of a proportion of older subjects in the present series did not affect these comparisons significantly. Even when patients of 40 years or older were excluded the percentage with antibodies at a titre of 1/8 or greater to all three viruses was only 35%.

In young persons absence of polioantibodies usually indicates that vaccination has not been carried out, but in older individuals it may be due to declining titres. A variety of reasons could account for the comparatively low level of immunity found in a mental deficiency hospital. A proportion of the patients will have been recognized as different from the general population from early in life and may have been treated differently as regards immunization procedures and degree of social mixing in the community. Some were admitted at an early age to hospital, and practically all had been in a closed community for several years and were therefore less exposed to chance acquisition of vaccine or wild polio virus.

It is not known how closely serum antibody titres equate with clinical immunity, and surface antibody may persist to give protection in the absence of detectable serum antibody. Nonetheless, the present study provides evidence that polio immunity may not be adequate in the population studied and suggests that booster programmes may be advisable in mental deficiency hospitals to reduce the risk of outbreaks of poliomyelitis.

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