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Sero-immunity to poliovirus in children and young women: England 1972–4

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SUMMARY

A total of 292 children's sera and 706 antenatal sera from different parts of England were tested for the presence of poliovirus neutralizing antibodies. Little variation was found between different areas and types of community, but a lower proportion of the 5–14 year old children had antibody than younger children and young adult women. The proportion of the young population with antibody, and the current acceptance rates for oral poliovirus vaccine are barely satisfactory.

INTRODUCTION

Epidemic poliomyelitis only occurs where wild poliovirus circulates and a susceptible population exists. Between 1947 and 1962 poliomyelitis was epidemic in England and Wales and many children excreted wild poliovirus. In a Public Health Laboratory Service survey (1958) of children under 5 years old in 1957–8 1·4 % of 8864 faecal specimens yielded poliovirus, and in the year 1957 3175 cases of poliomyelitis were notified in England and Wales (Martin, 1959). The introduction of inactivated poliovirus vaccine (IPV) in 1956 and of oral live attenuated poliovirus vaccine (OPV) in 1962 has since transformed the pattern of poliovirus infection, and from 1966 there have been fewer than 10 cases per year in England and Wales conclusively diagnosed as poliomyelitis. However poliovirus is still frequently isolated from children's faeces and 12 out of 180 (6·7 %) of strains examined in this laboratory in 1972 had the marker characteristics of wild strains. The neurovirulence of most of these strains has not been firmly established, but the introduction of wild strains by people travelling from countries where paralytic disease persists is unavoidable, and it must therefore be assumed that neurovirulent poliovirus continues to circulate in the community. The degree of immunity of the population to these strains is uncertain, and the objects of this investigation were:

(*a*) to compare serum poliovirus antibodies in people from selected parts of the country;
(*b*) to compare the proportions of young children, older children, and young adult women found to have antibodies;
(*c*) to establish a base line for screening local communities where immunity might be inadequate.

MATERIALS AND METHOD

Serum samples

The children's sera were obtained from laboratories throughout southern England, and had originally been referred for anti-streptolysin O estimations. The antenatal sera were obtained from eight laboratories widely spaced in England.

Tissue culture

HEp2 cells were grown in 199 medium with 8% bovine serum, 0·18% bicarbonate and 0·1% crystamycin (100,000 units/ml.). Tubes ($4 \times \frac{1}{2}$ in.) were seeded with 100,000 cells in 1 ml. of growth medium. After 48 hr. the medium was changed to a maintenance medium (199 with 2% fetal calf serum, 0·22% bicarbonate and 0·1% crystamycin) for inoculation.

Viruses

Three wild strains of poliovirus were used: Type 1 Mahoney, Type 2 YSK, and Type 3 Saukett. The viruses were propagated on monlayers of HEp2 cells in 6 oz. bottles, harvested and stored in small volumes at $-30°$ C.

Serum neutralization tests

The TCID50 of each strain was estimated, and a fresh sample, diluted to contain 100 TCID50, was used for each batch of tests. Sera were diluted 1/8 in 199 medium with 0·15% bicarbonate and 0·1% crystamycin, and tested by the method of Hambling, Davis & Macrae (1963), except that virus-serum mixtures were incubated for 3 hr. in a 37° C. waterbath before inoculation. Cultures were incubated in sloping racks at 36° C. and read after 6 days. Doubling dilutions of the British Standard antisera to Type 1, 2 and 3 poliovirus were included in each batch of tests. Tests in which titres of the British Standard sera fell outside the limits 1/128 and 1/512 were repeated.

RESULTS

Table 1 shows that 58% of 0–4 year old children, 42% of 5–14 year old children, and 63% of pregnant women had antibody at a titre of 1/8 to all three types of poliovirus. Of older children, 12% were without antibody to any type.

The results from the antenatal sera showed little variation between different areas, or between urban populations of > 150,000 (Leicester, Teesside, Kensington and Chelsea, Bristol and Liverpool) and smaller communities (Wisbech population 17,000, Truro population 14,800). The origin of the sera from Poole, population 106,700 was ascertained and the results of the sera from town and surrounding country are shown separately.

Table 1. *Neutralizing antibody at a dilution of* 1/8 *against poliovirus types* 1, 2 *and* 3

Sera	Number of sera examined	Percentage with antibody to: All three types	Type 1	Type 2	Type 3	Percentage with no antibody
ASO sera 0–4 years	107	58	83	85	71	5
ASO sera 5–14 years	185	42	70	74	61	12
Total antenatal sera	706	63	82	85	79	5
Antenatal sera from:						
Leicester	100	71	86	91	85	1
Teesside	100	63	88	91	77	1
Kensington and Chelsea	91	74	86	92	87	2
Wisbech	100	67	86	80	84	3
Bristol	47	51	81	81	72	6
Truro	75	52	75	72	69	11
Liverpool	99	58	83	72	70	12
Poole: urban	74	62	69	93	81	3
rural	20	70	80	95	85	5

Table 2. *Percentage of young children, older children and adults with and without antibody at the titre shown in five local surveys between* 1951 *and* 1957

Survey	Date	Age group	No. of sera	Screening dilution	% with antibody to poliovirus type: 1	2	3	Percentage with no antibody
Torridon, Ross and Cromarty*	1951	0–5	8	1/5	0	13	0	88
Southend, Essex*	1955–7	0–4	43	1/2	14	12	21	72
Betws-y-Coed, Caernarvon†	1954–5	0–4	22	1/10	73	41	18	23
Liverpool†	1955	0–4	14	1/10	36	43	29	29
Torridon*	1951	6–15	13	1/5	39	39	8	46
Southend*	1955–7	5–14	167	1/2	57	41	46	22
Betwys-y-Coed†	1954–5	5–14	56	1/10	73	73	62	5
Liverpool†	1955	5–14	57	1/10	70	70	44	2
London: Adult medical personnel*	1956	> 15	106	1/2	78	82	83	7

* A. D. Macrae (personal communication).
† Fallon (1956).

Table 3. *Percentage of children born in the preceding year who received poliovaccine by the end of the year stated*

1964	1965	1966	1967	1968	1969	1970	1971	1972
70	65	69	71	74	65*	63*	64*	64*

* Low rate due to changes in the recommended schedule of vaccination and immunization (Department of Health and Social Security: Annual Statistics 1973).

DISCUSSION

Attempts to demonstrate viraemia and therefore susceptibility to paralytic infection using oral challenge with attenuated poliovirus have only been successful in subjects with serum titres of < 1/2 (McKay, Fodor & Kokko, 1963). However these findings may not be directly applicable to challenge with wild virus, and screening at a dilution of 1/2 also raises doubts about the specificity of neutralizing activity, as well as allowing the toxic effect of low dilutions of some sera on tissue cultures to interfere with results. We therefore chose a screening dilution of 1/8 which represents a convenient conservative measure of immunity.

A few surveys of incidence of antibody to poliovirus at various screening dilutions were carried out before immunization was introduced into the United Kingdom and these are summarized in Table 2. These early results show wide variations between different communities and contrast with the much more uniform results obtained after seventeen years of poliovirus vaccination.

In our findings sera from smaller communities had at least as much antibody as those from large cities and it appears that immunity may now be poorer in large urban areas where children from some social groups are not immunized, or do not complete courses of vaccine. The total immunization rate for England and Wales (Table 3) was about 70%, but may have fallen slightly since 1969. Pockets of suceptibility probably exist in some British cities where OPV acceptance rates fall well below this figure. In Glasgow, for instance, Reid, Bell, Grist & Wilson (1973) found that only half of a group of 75 nursery school children had been fully vaccinated and that half of the group lacked triple immunity.

The finding that a higher percentage of 0–4 year old children than of 5–14 year old children had antibody titres of $\geqslant$ 1/8 cannot be explained by any recent rise in the acceptance rate for infant vaccination. It suggests that serum antibodies do not persist as long after OPV as they have been shown to after IPV (Bottiger, 1969), and that recommended booster doses of OPV are not generally being given. It is likely that adult immunity will fall as these 5–14 years olds grow up.

At present the immunity of young adults, as represented by the antenatal sera examined here, is more satisfactory, reflecting perhaps the higher serum antibody titres found after immunization with IPV. This vaccine was widely used in the United Kingdom between 1956 and 1961 and 60–80% of the age group to which the pregnant women in this study belong received at least two doses (Ministry of Health, 1962). Their current antibody status is still comparable with that of the much more recently immunized 0–4 year age group.

It is difficult to relate these results to susceptibility to poliomyelitis but it is clear that the children in the 5–14 year old age group are relatively poorly protected. Meanwhile immunization rates in England and Wales are at a figure at which sporadic outbreaks of paralytic disease can occur, and this threat should be met by raising acceptance rates for OPV to those achieved elsewhere. In New South Wales for instance 80% of children receive a course of primary immunization with OPV (Fisher, 1974). In Sweden, where three injections of IPV are

given in the first year of life, acceptance rates are as high as 94% (Bottiger, 1969). The danger in the United Kingdom is that after 15 years almost free from epidemic poliomyelitis most young parents are unfamiliar with paralytic disease and may therefore not appreciate the importance of immunization. We agree with Reid *et al.* (1973) that more effort should be directed towards vaccinating children with OPV, particularly at school entry. The ease with which OPV can be given and the effectiveness with which vaccine strains are disseminated should encourage freer use of this vaccine among young children.

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