to respond to type 2 also; the third infant not responding to type 1 had failed to become infected by this type, whereas he gave good responses to types 2 and 3, with which he had been infected. The third infant failing to respond to type 2 responded to types 1 and 3, and the single infant not responding to type 3, which had failed to infect, gave good responses to types 1 and 2, which had infected. In general, gut infection was associated with antibody response, but in some (notably in relation to type 1) a good response was obtained in infants from whom virus was not isolated. This discrepancy is most likely due to the small number of faecal samples taken and failure to isolate virus from short-lived infections.

Summary

Good antibody responses were obtained to all three virus types in 25 of 30 3-months-old infants who were given three doses of trivalent oral poliomyelitis vaccine at six-weeks intervals. The remaining five infants gave good antibody responses to one or two of the virus types.

The few infants who failed to respond were among those with the highest antibody titres before immunization. It is possible that, in these, maternal antibody had masked but not inhibited response; this question can

be resolved only when the response to a booster dose given six to nine months later is known. If it proves to be satisfactory it will be possible to offer quadruple antigens in the form of either D.T.P. (diphtheria, tetanus, pertussis vaccine) + Salk vaccine or D.T.P. + oral trivalent Sabin vaccine, for routine immunization starting at 3 months of age.

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POLIOMYELITIS IN A NURSERY SCHOOL IN GLASGOW

BY

W. J. PATTERSON, M.B., Ch.B., D.P.H., D.P.A.
*Divisional Medical Officer, Health and Welfare Department,
Corporation of Glasgow*

ELEANOR J. BELL, Ph.D., B.Sc.
*Regional Virus Laboratory of the University of Glasgow,
Ruchill Hospital*

Very few cases of poliovirus infection were detected clinically or virologically in the West of Scotland for three years following the outbreak of 1958 (Bell and Grist, 1962). The finding of two cases of poliovirus type 1 infection in November, 1961, in the same nursery school was therefore remarkable.

This nursery school has accommodation for 40 children and at the time there were 37 children aged from 3 to 5 years on the roll. The staff consisted of one teacher, four nursery assistants, one student nursery assistant, two cleaners, and one dining-room attendant; their ages ranged from 17 to 45 years. In November, 1961, two pupils of this school were found to be suffering from poliomyelitis. There had been four cases of poliomyelitis (three of poliovirus type 1 and one of type 3) in Glasgow during the preceding two months.

Case 1.—J. H., a boy aged 4 years 3 months, was last at school on November 10. He became unwell later that day and was admitted to hospital on November 15. He had an aseptic meningitis and a temporary paralysis of the muscles supplied by the right facial nerve. There was no paralysis of the limbs. A specimen of faeces taken on November 16 was examined virologically with negative results, but poliovirus type 1 was cultured from a second specimen taken on December 1. He had received two doses of inactivated vaccine in May and June, 1961.

Case 2.—M.H., a girl aged 3 years 6 months, had a transient illness on Friday, November 10. On waking from her afternoon sleep that day she cried and refused her tea. In the children attending nursery schools such behaviour at that time of day is often the first sign of the onset of a febrile illness. She was sent home, but on Monday, November 13, she returned to school in her normal health.

This transient illness, occurring on the same day as her school-mate (Case 1) sickened of poliomyelitis and 11 days before she herself sickened of poliomyelitis, may have been due to the early phase of viral invasion or merely coincidental. Conybeare (1946) described similar illnesses 12–13 days before onset of poliomyelitis. After this brief illness she remained well until November 21, but on waking from her afternoon sleep that day she was pale and trembling and obviously ill. She was sent home immediately and was admitted to hospital a few hours later. She had an aseptic meningitis but no paralysis. Poliovirus type 1 was cultured from a specimen of faeces taken on November 22. She had not been immunized against poliomyelitis.

The second patient had been admitted to hospital with a provisional diagnosis of cerebrospinal fever. On the afternoon of November 29 it was reported to the Health and Welfare Department that virological investigation had established the diagnosis of non-paralytic poliomyelitis. At the same time it was reported that the first patient, who had been admitted with a provisional diagnosis of tuberculous meningitis and who was a pupil of the same nursery school, might also be suffering from poliomyelitis though at that time the virological results were negative.

Preventive Measures

At this stage it became necessary to decide what administrative action should be taken to prevent the spread of infection. The school premises were inspected on November 30 and found to be in satisfactory condition. Since infection had already had time to spread throughout the school, immunization with inactivated vaccine (the only type then available) was not offered.

Most of the children were already at least partially immunized (see Table II). It was decided that closing the school at this late stage would not prevent further cases. Moreover the children could be kept under observation in school, where the hygienic conditions were much better than in most of their homes, and even if the school were closed the children, who came from a small district, would probably be playing together in the streets or in their homes.

We took the opportunity to determine by virological investigation how far the infection had in fact spread. Specimens of faeces were obtained from all the remaining children and from all the members of the staff, most of them on December 6, the others within a day or two after. Children who were off school for any reason were visited in their homes and specimens were obtained from them also. The results are set out in Table I. Not one of the staff was found to be a carrier, but of the 35 children examined, 7 were carrying poliovirus type 1. Including the two original cases, the total number of children infected was 9 out of 37 (almost 25%). Only one specimen was taken from each child; if more specimens had been examined, or if they had been taken a few weeks earlier, the number of carriers discovered might have been even higher.

seven carriers included three children with histories of fever and headache, cold, and "bronchitis" respectively. The other four carriers had no history of any noticeable illness which could have been abortive poliomyelitis. Thus there was no association, greater than would have been due to chance alone, between symptoms suggestive of abortive poliomyelitis and the carrier state.

The question now arose whether the seven detected carriers should be excluded from school. It was decided that they should be allowed to remain at school. There were several reasons for this decision. First, as only one specimen had been taken from each child it was possible that there were more carriers than had been detected. Secondly, it was probable that the carrier state had been widespread throughout the school and had created a high level of immunity, the absence of further cases supporting this hypothesis, and it was therefore considered that the carriers would do less harm in that nursery school than anywhere else in the city. Finally, it would have been difficult to determine the duration of exclusion, for we had little idea how long the carrier state might last.

One child, who had been previously immunized with three doses of inactivated vaccine, had been off school since November 6 because of scarlet fever. She was

TABLE I.—*Virus Isolations*

Subjects	Sex	Age	Inactivated Vaccine Given	6/12/61	9/1/62	30/1/62	13/2/62	28/2/62
J.H.	M	4	2 doses in 1961	—	Polio 1	Negative	Negative	Negative
M.H.	F	3	Nil	—	" 1	"	"	Untyped virus
R.B.	M	3	3 doses, last in 1960	Polio 1	Negative	"	E.C.H.O. 11	E.C.H.O. 11
J.M.	M	4	2 doses in 1959	" 1	Polio 1	"	Negative	Negative
A.D.	M	5	Nil	" 1	" 1	"	"	"
A.W.	M	4	3 doses, last in 1959	" 1	Negative	E.C.H.O. 6	E.C.H.O. 6	E.C.H.O. 6
M.F.	F	4	2 doses in 1958	" 1	Polio 1	Negative	" 11	Negative
A.M.	F	3	Nil	" 1	" 1	Polio 1	Negative	Coxsackie A9
C.O.	F	3	"	" 1	" 1	Negative	"	"
S.R.	M	4	"	E.C.H.O. 11	—	—	—	Negative
M.C.	M	3	2 doses in 1961	Untyped virus	—	—	—	—
P.M.	F	3	1 dose in 1959	Negative	—	—	—	E.C.H.O. 11
25 other children	10 M } 15 F }	3-5	(See Table II)	"	—	—	—	Negative (1 not examined)
9 adults	F	17-45	6 immunized. 3 not immunized	"	—	—	—	—

Table II shows that 13% of triply immunized children were found to excrete poliovirus, as compared with 33% of those who had received two doses and 31% of those who had received no vaccine or only a single dose. One child, A.W., was carrying poliovirus on December 6, though he had been excluded from school, because of dysentery in his family, from November 9—that is, before the onset of symptoms in the first case.

It was thought that in this school there might have occurred some cases of abortive poliomyelitis, not recognizable as such clinically, but manifested by upper respiratory infections or undiagnosed fevers associated with positive virological results. Inquiry was therefore made at the school on December 6 (the day most of the specimens were taken) and it was learned that 14 of the 35 children had recently had either upper respiratory illnesses or undiagnosed febrile conditions. When virological results were received it was found that the

given a fourth dose of inactivated vaccine on December 22 and allowed to return to school, after the New Year holidays, on January 3. No new children were admitted to the school, though there were a few vacancies.

On January 9 further specimens were taken from the two original patients (who had been allowed to return to school) and the seven detected carriers. J.H. was still excreting poliovirus 59 days after the onset of his illness; the culture was positive after 48 hours' incubation, indicating that the virus was present in fairly large quantity. M.H. was still excreting poliovirus 48 days after the onset of her illness. Five of the seven carriers were still excreting five weeks after their first positive specimens had been taken. It is notable that the two carriers whose specimens were negative at this examination were the two who had previously been immunized with three doses of inactivated vaccine.

A third series of specimens was taken on January 30, when one child, who had not been immunized against poliomyelitis, was still excreting poliovirus 55 days after her first positive specimen had been taken. Further specimens were taken, on February 13 from these nine children and on February 28 from all the children in the school (one having left the district). No more poliovirus was found, but the results (Table I) showed the emergence of other enteroviruses.

TABLE II.—*Incidence of Cases and Carriers of Poliomyelitis in Relation to Poliovaccination*

Inactivated Vaccine Previously Received	Total in School	Cases	Carriers
None	10	1	3
One dose	3	—	—
Two doses in 1958-60	6	—	2
" " " 1961	3	1	—
Three doses	15	—	2
Total	37	2	7

Virological evidence that there were still several poliovirus carriers in the school posed a serious administrative problem. Six of the children, having reached the age of 5, were due to be transferred on January 29 to three different primary schools. One of these six was a known carrier, and it was possible that some of the others were undetected carriers. We thought that the continuing presence of carriers in the nursery school would be unimportant but that spread of infection by transfer of these children to other schools was undesirable. It was decided that no children from that nursery school (whether known carriers or not) were to be transferred to primary schools, and no children (whether immunized or not) were to be admitted to that nursery school, until poliovirus infection had died out. The Education Department co-operated fully, the parents raised no objection, and the restrictions remained in force until March 29, when we were able to say, from the results of the subsequent virological examinations, that the school was free from poliovirus infection.

Discussion

It is clear that a child recovering from poliomyelitis may continue to excrete poliovirus for a period much in excess of 21 days, the traditional period of isolation in hospital. However, it is also clear that the infection may be established in the patient's environment before his removal to hospital and is likely to be widespread (at least among the children) in this environment before the patient's return. (It is notable that none of the nine adults on the staff of the nursery school was found to be infected, but contact between staff and pupils in a nursery school is not strictly comparable to contact between adults and children at home.) Thus no harm is likely to result from the patient's return, even while still infectious, to his original environment, which is probably already infected. The danger arises when the patient, or any person (especially a child) in his circle of contacts, changes his environment, as by transferring to a new school. If restrictions are placed on the movements of contacts during a period of "quarantine" this period must last several months.

In the later stages of poliovirus infection the quantity of virus excreted in the faeces diminishes and may be intermittent. As in the case of other enteric infections, this may lead to difficulties of interpretation of the significance of negative routine tests of single specimens, and, moreover, it may be impracticable to examine multiple specimens or use concentration methods, particularly if the outbreak is large. It is well known that communities of children regularly experience successive waves of infection by different enteroviruses, one displacing the other as the prevalent agent (Bell *et al.*, 1961). The eventual emergence of enteroviruses other than poliovirus in our group of nursery children, as in the incident described by Selwyn and Howitt (1962), may thus provide stronger evidence of the termination of the poliovirus episode than the mere finding of negative specimens (Hale *et al.*, 1961).

Summary

An outbreak of poliomyelitis in a nursery school in Glasgow is described. After the occurrence of one paralytic case and one non-paralytic case, seven carriers were found by virological examination of the remaining 35 children. No carriers were found among the staff. The carrier state was less common in children who had had three doses of inactivated vaccine. There was no

correlation between the carrier state and symptoms suggestive of abortive poliomyelitis. The carrier state lasted several weeks. The problems of the administrative control of infection are described.

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SELECTIVE NERVE CRUSH OPERATION FOR RELIEF OF INTERMITTENT CLAUDICATION

BY

WILLIAM REID, F.R.C.S.Ed., F.R.C.S.G.

J. KENNEDY WATT, B.Sc., F.R.C.S., F.R.C.S.G.

AND

THOMAS G. GRAY, M.C., F.R.C.S.Ed.

Royal Infirmary, Glasgow, and Peripheral Vascular Unit,
Belvidere Hospital, Glasgow

Arterial occlusion in the lower leg is most commonly due to atherosclerosis, and may lead to the development of intermittent claudication or gangrene. When claudication is present the degree of economic and social handicap produced is proportional to the limitation of walking-distance imposed. If this is severe the patient may be able to work but unable to reach his work because of claudication.

The aim of treatment is to increase the walking-distance, but attempts to do so are often disappointing. Arterial grafting or thrombo-endarterectomy is effective in selected cases, but, as Boyd (1960) points out, this is possible in approximately 10% of patients. We have found (Reid *et al.*, 1961) that phenol injection of the lumbar sympathetic chain has a wider application in treatment and improves substantially about 35% of patients with femoro-popliteal occlusions.

There remain a group of patients unsuitable for arterial surgery in whom sympathectomy has given a good temperature response but has not increased the claudication distance. The operation of selective nerve crush was devised in 1950 in association with Mr. J. Sloan Robertson as a means of improving the walking ability of this type of patient.

Crushing of the nerves to gastrocnemius and soleus produces wasting of these muscles and reduces their oxygen requirements on exercise, yet sufficient regeneration occurs to restore muscle tone. This allows the patient to walk further without limping and also ensures adequate venous return.

As the operation is concerned with function and does not improve ischaemia it has a limited application. It should be considered in patients who are unable to work because of claudication limited to the calf muscles,