Antibody Levels Against Polioviruses in Children Following Pulse Polio Immunization Program

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This cross sectional study was performed in a tertiary level teaching hospital to evaluate and compare the antibody levels in children below 6 years who had received oral polio vaccination through Pulse Polio Immunization (PPI) with those children who had received both routine immunization as well as PPI. Detail history of polio immunization was taken. Serum samples were then collected for antibody determination by neutralization tests with standard polio viruses using Vero cell lines. Total 400 children were studied; 14 were found unvaccinated. Out of the remaining 386 (96.5%) vaccinated children, 292 (75%) had received both routine and pulse polio immunization, 68 (17%) had only PPI while 26 (6.7%) had received only routine immunization. The seropositivity was lowest for P3 and highest for P2. Overall seroprevalence for PI, P2 and P3 in vaccinated children was 89.1%, 93% and 80.6% respectively, and did not differ significantly between the three vaccinated subgroups. However, children who were immunized by both routine and PPI had higher geometric mean titers (315.5, 484.7 and 187.4 for PI, P2 and P3 respectively) when compared with those who had received only PPI ($P<0.001$ for each PI, P2 and P3), as well as those who had received only routine immunization with OPV ($P<0.05$ for PI, $p<0.001$ for P2, and $P<0.01$ for P3). Despite the reasonable immunization coverage in study population, there were 29 (7.25%) triple negative cases. Hence other causes of low seroconversion should also be considered to achieve polio free India.

Key words: *Oral polio vaccine, Pulse polio immunization, Seropositivity*

To achieve the global eradication of poliomyelitis, in 1995 India adopted the strategy of pulse polio immunization program (PPI) on national immunization days along with the routine national immunization program (NIP). Inspite of all the sincere efforts by various agencies for last seven years, cases of paralytic poliomyelitis are being reported from some states of India(1). There has been alarming persistence in the transmission of polioviruses in states like Uttar Pradesh. Hence, we felt that an objective evaluation should be done to know the effect of pulse polio immunization program (PPI) in Aligarh (Uttar Pradesh), a pocket from where large number of cases of paralytic poliomyelitis has been reported in the last few years. We assessed quantitatively the antibody response in children who have had vaccination of OPV both by PPI program and routine national immunization program (NIP) and compared them with antibody titers of those children who had received OPV only through PPI or NIP.

Subjects and Methods

Four hundred randomly selected children between 6 months to 6 years of age who attended the Pediatrics outpatient department and the urban health center of J.N. Medical

College, AMU, Aligarh were studied during June 1999 to August 2002. Children with major illnesses were excluded. A detail history of immunization was first taken and confirmed where possible by crosschecking the vaccination record. For the purpose of analysis selected children were divided into two major groups on the basis of their immunization status (*Table 1*). Group I constituted 386 (96.5%) vaccinated children while Group II was of 14 (3.5%) unvaccinated children. Group I was further subdivided into 3 subgroups. Subgroup A consisted of 68 (17.6%) children who had received OPV only through PPI, subgroup B consisted of 26 (6.7%) children who had received vaccination only in the routine immunization and never had OPV during the NIDs while in subgroup C 292 (75.7%) children had received OPV both during PPI and routine immunization program.

After obtaining consent from the parents/ guardians, 5 mL of blood was collected in sterile tubes. Serum was separated from the blood samples and stored at –20ºC till it was tested. Polioviruses neutralization antibody tests were conducted using Vero cell lines. A titer of 1:10 and above was taken as significant. Neutralization tests were done in tissue culture tubes with standard polioviruses using 100 TCID50. The lowest and highest serum dilution tested was 1:10 and 1:1028 respectively. Complete inhibition of cytopathic effect was regarded as neutralization of poliovirus with the sera.

Geometric mean titers (GMT) of antibodies were calculated for each category of cases. Student's t-test was used to compare the groups. Significance was defined by $P < 0.05$.

Results

Seropositivity in the vaccinated children (Group I) was 89.1%, 93% and 80.5 % for PI, P2 and P3 respectively (*Table II*). The total

TABLE I–*Seropositivity in Different Vaccination Categories.*

Group	No. of children	Number of OPV doses: Mean (Range)	Antibodies present against*			Triple positive cases (%)*	Triple negative cases (%)*
			P1 (%)	P2 (%)	P3 (%)		
Group I (Vaccinated)	386	7.8 (2-18)	344 (89.1)	359 (93.0)	311 (80.5)	280(72.5)	22(5.7)
Subgroup A (PPI§ only)	68	6.3 (3-12)	59 (86.8)	62 (91.2)	52 (76.4)	52 (76.5)	4 (5.9)
Subgroup B (NIP‡ only)	26	3.8 (2-5)	21 (80.8)	24 (92.3)	18 (69.2)	17 (65.4)	2 (7.7)
Subgroup C (PPI + NIP)	292	8.4 (2-18)	261 (89.4)	273 (93.5)	241 (82.5)	228 (78.1)	16 (5.5)
Group II (Unvaccinated)	14	0	5 (35.7)	7 (50.0)	2 (14.3)	2 (14.3)	7 (50.0)

§ PPI: Pulse Polio Immunization; ‡ NIP: National Immunization Program.
* Figures in parantheses are percentages of the total number of children in respective group/subgroup.

triple negative cases among the vaccinated children were 22 (5.7%) and total triple positive cases were 297 (76.9%).

GMT in the vaccinated group was 290.2, 469.5 and 173.7 for PI, P2 and P3 respectively (*Table II*). In the children vaccinated only by PPI (subgroup A), seropositivity was 86.8%, 91.2% and 76.5% for P1, P2 and P3 respectively (GMT: 136.1, 261.2 & 84.1 for P1, P2 and P3 respectively). Triple positive cases were 52 (76.5%) and triple negative were 4 (5.9%). Seropositivity of children who had received OPV doses only through NIP (Subgroup B) showed values comparable to those who received only PPI.

In the 292 children who were immunized by both routine and mass campaigns (Subgroup C), the GMT was higher than those vaccinated by PPI or NIP alone. Triple negative cases were 16 (5.5%) and triple positive were 228 (78.1%). Among the 14 unvaccinated children (Group II), the seroprevalence for PI was 35.8%, for P2 50% and for P3 it was 14.3% (GMT was 11.5, 14.9 and 14.1 respectively). There were 7 triple negative cases and only 2 children had antibodies to all 3 polio viruses.

Discussion

In our study maximum seropositivity was for P2 followed by PI and least for P3 (*Table I*). Similar high seropositivity in P2 has been reported by earlier studies(2,3). Other investigators have found maximum seropositivity for PI and least for P3(4,5).

Though many rounds of PPI have been conducted with intensified efforts, there were still 10% (40/400) children in this study who had not been reached by PPI although 6.5% (26/400) of these were covered by National Immunization Program. No significant differences were observed in the seroprevalence of children who took OPV through either routine immunization or pulse polio programme or from both. In contrast consistently higher seroprevalence in subgroups that received 2 doses through mass campaigns than in subgroups that received vaccination only by routine immunization has been noted by other studies(6,7).

TABLEII-–*Geometeric Mean Titer of Polio Virus Antibodies.*

Group	No. of children	Number of OPV doses:	Geometric mean titers of antibodies *		
		Mean (Range)	P1	P2	P3
Group I (Vaccinated)	386	7.8 (2-18)	290.2	469.5	173.7
Subgroup A (PPI only)	68	6.3 (3-12)	136.1	261.2	84.1
Subgroup B (NIP only)	26	3.8 (2-5)	52.7	160.1	33.5
Subgroup C (PPI+ NIP)	292	8.4 (2-18)	315.5	484.7	187.4
Group II (Unvaccinated)	14	0	11.5	14.9	14.1

*Comparing GMT in Subgroup A vs. C : P <0.001 for each PI, P2 and P3

Subgroup B vs. C : P <0.05 for PI, P<0.001 for P2 and P <0.01 for P3

Subgroup A vs. Group II : P <0.001 for each PI, P2 and P3

Subgroup B vs. Group II : P <0.01 for PI, P<0.001for P2 and P<0.05 for P3

Key Messages

- Even with high OPV immunization coverage triple negative cases are seen.
- Other causes of low seroconversion should also be considered to ensure success of Polio Eradication Program.

However, while the seroprevalence were not significantly different in the three vaccinated subgroups, the GMT of subgroup C that received both routine and pulse immunization was higher than those of subgroup A (PPI alone) (P <0.001 for each PI, P2 and P3) as well as subgroup B (NIP only) (P <0.05, <0.001 and <0.01 for PI, 2 and 3 respectively (*Table II*). This result highlights the need and significance of strengthening routine immunization along with the PPI.

Another interesting observation was that unimmunized children had poor antibody prevalence, which suggests poor transmission of OPV viruses and hence contradicts the widely held perception that OPV has the advantage of transmissibility. However, this result needs confirmation, as the number of cases in the unimmunized group was less.

Nightangle had reported that control of poliomyelitis could be achieved by properly immunizing 80-85% of the population(8). We noted reports of cases of poliomyelitis from Aligarh even during the period of this study despite the good immunization coverage of 96.5% observed in our study sample. It may be argued that this being an urban, hospital-based study, the vaccination rates observed in the study sample may not correctly represent that in the community. However, despite the reasonable OPV coverage among the 400 children studied, there were 29 (7.25%) triple negative children of which 22 (5.7%) had received OPV through either routine or pulse polio immunization or both (*Table I*). Various causes of low seroconversion in a developing country like India have been stated. Some of them are interference due to concurrent enteroviral infection, interference among serotypes of OPV and poor hygiene(9,10). Also breaks in cold chain and suboptimal practices of vaccine handling could be attributed to low seroprevalence in a population(11). Therefore, besides the causes already identified for the setbacks in the polio eradication programme(12), reasons for low seroconversion should also be investigated and rectified to achieve polio eradication.

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