Epidemiological Report

OUTBREAKS OF PARALYTIC POLIOMYELITIS AND POLIO SURVEILLANCE IN SHANDONG PROVINCE OF CHINA

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SUMMARY: Widespread outbreaks of paralytic poliomyelitis occurred in Shandong province, China, starting from 1988. In 1989, 484 cases were recorded, which was the peak during the past 4 years. Although emergency immunization with trivalent oral poliovirus vaccine (OPV) was carried out in selected counties in 1989 and 1990, control of the outbreak was not satisfactory. OPV mass immunization campaigns were introduced to cover the whole province in early 1991, and the number of patients with paralytic poliomyelitis decreased to 95. In
addition to this new immunization strategy, we began to construct new polio surveillance systems. These were a network for case-negative reporting and an immediate reporting system of acute flaccid paralysis (AFP). As for the case-negative reporting, presently more than 90% of counties have been reporting presence or absence of new AFP cases. Monitoring of AFP immediate reporting has also shown a gradual improvement in several aspects. These polio surveillance activities are crucial to polio eradication programme management.

INTRODUCTION

Paralytic poliomyelitis has been virtually eliminated in many industrialized countries during the past three decades. In the developing world, countries in Central and South America have succeeded in full interruption of wild-type poliovirus transmission after introduction of a poliomyelitis eradication program steered by the Pan American Health Organization (PAHO) (1). These results greatly encourage other nations to seek polio eradication by the year 2000 (2).

In China, polio infections had well been controlled by the middle of 1980’s through the development of the Expanded Program on Immunization (EPI) all over the country. However, outbreaks recurred since 1988 and cases of paralytic poliomyelitis exceeded 5,000 in 1990 (3,4). Causes of this are likely to be related to the alteration of the EPI infrastructure as influenced by recent socio-economic changes. Similarly, in Shandong province, polio outbreaks occurred in a limited area in 1988, then spread broadly into the western half of the province. In the present paper, we describe these outbreaks primarily focussing on the situation during 1989 to 1991, together with the surveillance activity introduced in Shandong province from 1991.

Background

Shandong province is located in the east coast of middle China and its inland is surrounded by Hebei, Henan, Anhui and Jiangsu provinces. It consists of 16 administrative regions (prefectures), each of which has about five to 10 counties comprising 134 counties in total. The population was approximately 84 million in 1990 and more than 70% of the people reside in agricultural villages in rural areas. EPI networks including the cold chain system had been completed by
1987. In 1986 and 1987, only about 70 cases of paralytic poliomyelitis were reported to the Provincial Epidemic Prevention Station (EPS). In 1988, however, a polio outbreak began in Dezhou prefecture in the northwest of the province and in the subsequent 2 years it spread widely to the counties in the western half of the province. Outbreak control was not successful despite introduction of supplemental emergency immunization with trivalent oral polio vaccine (OPV). Besides, lack of an adequate polio surveillance system hampered establishment of an effective strategy. From the end of 1990, a team of JICA consultants joined Shandong provincial EPS to initiate cooperation for establishing polio surveillance systems as well as promoting overall EPI and polio eradication programs.

Reported coverage with OPV and paralytic poliomyelitis during 1985-1989

Reported coverage with three doses of OPV before the first birthday was more than 90% after 1987 when the EPI cold chain networks completed in Shandong province. Only 70 to 85 cases were reported annually during 1985 to 1987. In 1988, despite high OPV coverage, the number of cases increased to 223 (0.26/100,000 population), which accounted for 33% of all the cases in China in the same year. It further increased to 484 (0.58/100,000) in 1989, which accounted for 10% of the national total number.

Outbreaks in 1990 and 1991 and effects of OPV mass immunization campaign

Monthly distributions of cases in 1990 and 1991 are shown in Fig. 1. The seasonal character of the epidemic in 1990 was less clear, with a major outbreak beginning from January in Heze prefecture in the southwest of the province. The local EPS started urgent immunization from April in case-occurring counties and their neighbors. This immunization activity was conducted also in possibly high-risk counties or townships of other prefectures in subsequent months. Nevertheless, an extensive outbreak occurred in Ningyang county of Taian prefecture peaking in July. About 5.6 million doses of OPV were used for emergency immunization for this year but, as a result, the number of cases remained at 284 (6% of the national total).

In 1991, a whole province OPV immunization campaign was carried out for the first time with 13 million doses of OPV in two sessions. In the first session held in January, all children aged below 47 months were immunized. In the second session (April), children aged below 35 months in 93 polio-endemic
counts (69% of total counties) were included. As a result, the number of paralytic polio cases decreased by about 60% from 284 in 1990 to 95 in 1991.

**Geographic Distribution**

County-level distributions of cases during 1989 to 1991 are shown in Fig. 2. Epidemics occurred mainly in rural villages of many counties in the west and south of Shandong provinces. Large outbreaks were often seen in marginal areas (counties) of a prefecture, which share the border with a neighboring province. It should be noted that the focus of outbreaks migrated each year, suggesting that poliovirus infections were sustained by a widely existing large population susceptible to this virus. Although in 1991 a large epidemic was seen only in Dongming county of Heze prefecture (23 cases), the infections do not seem to have been confined geographically to a specific area.

The number of polio epidemic counties was 63 in 1989 and it decreased to 44 in 1990 (Table I). In 1991, cases occurred in the same number of counties, but the
Fig. 2. Geographical (county level) distribution of paralytic poliomyelitis in 1989, 1990 and 1991.
extent of infection became relatively small. In 1990, there were 10 counties where more than 10 patients were reported, while such an outbreak was seen only in one county in 1991.

Age, gender and immunization history

Age distribution of the cases in 1990 and 1991 are shown in Fig. 3. In both years, more than 90% of patients were aged less than 3 years. Cases occurred more frequently in males, with the male to female ratio being 1.53:1, although reasons for this phenomenon are not known. Immunization with OPV (three doses) had not been completed in 85% of cases (242 cases) in 1990 (Fig. 4) and even a single dose had not been administered in 51% (144 cases). In 1991, in accordance with overall decrease of cases, the proportion of subjects who lacked any OPV immunization history decreased to 24% (23 cases), while there was a relative increase of cases with a history of three or more doses of OPV (20 cases, 21%). This may have partly been a reflection of the absolute decrease in the unimmunized population as a result of the OPV mass immunization campaign held in early 1991 in this province.

Birth history

Birth order of cases are shown Table II. In 1990, this information was lacking in more than half of the patients. Out of 95 patients in 1991, 41 cases were the 2nd child and 15 were the third child or a higher order birth. Among these two groups of children, 41 (43% of the total) were not enrolled in census registration.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Number of counties (%)</th>
<th>1989</th>
<th>1990</th>
<th>1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>23(36.5%)</td>
<td>17(38.6%)</td>
<td>27(61.4%)</td>
</tr>
<tr>
<td>2 – 9</td>
<td></td>
<td>28(44.4%)</td>
<td>17(38.6%)</td>
<td>16(36.4%)</td>
</tr>
<tr>
<td>10 ≤</td>
<td></td>
<td>12(19.0%)</td>
<td>10(22.7%)</td>
<td>1(2.3%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>63</td>
<td>44</td>
<td>44</td>
</tr>
</tbody>
</table>
Fig. 3. Age distribution of paralytic poliomyelitis cases in 1990 and 1991.

Fig. 4. OPV immunization history of paralytic poliomyelitis cases in 1990 and 1991.
Table II. Birth order of paralytic poliomyelitis cases

<table>
<thead>
<tr>
<th>Years</th>
<th>Cases by the birth order</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1990</td>
<td>47</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>(16.5%)</td>
<td>(14.4%)</td>
</tr>
<tr>
<td>1991*</td>
<td>37</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>(38.9%)</td>
<td>(43.2%)</td>
</tr>
</tbody>
</table>

*Forty-one cases (43.2%), 28 of the 2nd child group plus 13 of the 3rd child group were census unregistered.

Polio surveillance and its monitoring

With regard to the case-negative-reporting system, more than 90% of county EPS reported regularly to prefectural level EPS about the presence or absence of new AFP cases in the later half of 1991. However, it took at least one month for this information to arrive at the provincial surveillance team (data not shown).

AFP immediate reporting also began from early 1991 and through this system, 231 AFP and AFP-suspected children were reported to the provincial EPS as cases having occurred in the same year. Of these, 95 cases were classified into paralytic poliomyelitis as has been described above, while 136 cases were excluded. The provincial surveillance team put particular emphasis on the examination of cases excluded at county level so that subjects with very mild poliomyelitis would not be overlooked. Cases with non-polio paralytic illnesses included 23 patients with Guillain-Barre Syndrome (GBS) and 10 patients with myelitis. The remaining subjects were either normal or children having symptoms or signs of other than acute flacid paralysis (AFP). Sixty-seven percent (91 cases) of the discarded cases had an immunization history with three or more doses of OPV in contrast to 21% seen in poliomyelitis confirmed cases.

Polio surveillance activity in 1991 was monitored by use of several indicators. Of the 231 AFP cases in 1991, approximately 50% (115 cases) were notified to local EPS 0 to 7 days after patients consulted county hospitals or other curative care facilities, a situation which was not clearly improved compared to 1990. Meanwhile, cases investigated within 7 days by local EPS increased from
35% in 1990 to 78% in 1991. However, overall length from onset of paralysis to investigation by county EPS was not clearly shortened in 1991. Stool specimens were collected from 58% of AFP in 1991, but only 21% were taken in 7 days after onset of AFP. It is apparent that collection of appropriate stool samples also depends upon both the speed of reporting AFP and the subsequent investigation by local EPS.

**DISCUSSION**

Shandong province's recent poliomyelitis outbreak began in 1988 in Dezhou prefecture in the northwest and it spread widely to the west half of the province in subsequent years. Outbreaks occurred mainly in rural towns or villages. Very few polio cases were reported from urban areas of large cities, where generally EPI activity had been well sustained. One of the problems underlying this was thus the trend recently seen among a certain portion of grass-root health workers to ignore public health duties as well as the practice of EPI. Another important cause would be the increase in so called out-of-plan children who generally remained unregistered for EPI and thus unimmunized with OPV. This leads eventually to accumulation of enough children to allow spread of poliovirus infection. Although OPV coverage was reported to have reached high levels, these EPI unregistered children have not often been included in the denominator as the actual eligible population for OPV immunization. It should be mentioned that grass-root health workers, particularly those at village level, are also responsible for EPI registration of newborn infants. These problems might commonly exist all over China (6,7).

In Shandong province, approximately 7 million doses of OPV have been used annually for the routine immunization. Although the exact OPV coverage rate in the polio epidemic or endemic areas was not known, zones with very low herd immunity might have extended through the west half of Shandong province. In 1989 and 1990, an additional 5 to 5.6 million doses of OPV were distributed to outbreak-occurring counties and townships, and to their neighbors. However, this emergency immunization did not seem to be very successful in controlling ongoing epidemics of poliomyelitis.

The OPV mass immunization campaign has been widely introduced in the Americas and it has lead PAHO regional countries to the successful elimination
of paralytic poliomyelitis (1,8). Although these results clearly indicated the effectiveness of campaigns even in countries without a fully established EPI infrastructure, an essential role of this strategy also exists in interruption of wild polio virus transmission through broadly immunizing children of wide age groups within a short period of time. Even immunization with three doses of OPV by the routine schedule might not be enough to interrupt transmission of wild polio virus in an environment where general hygiene is substandard and hence polio infections might be highly endemic (9-11). In Shandong province, where polio infection occurs mainly in children below 3 years old, reinforcement of specific immunity of this age group seems essential for control of this disease.

Shandong province carried out an OPV mass immunization campaign for the first time in early 1991 and a substantial decrease in cases has been observed. In Dongming county where 23 cases were reported in 1991, the outbreak had begun from the end of 1990 and overall performance of the mass campaign was also poor as revealed later by the provincial team's investigation. In any event, results so far obtained seem to indicate that the OPV mass immunization campaign is a promising strategy for eradication of polio in China.

Polio surveillance in developing countries needs to be sensitive enough to detect as many AFP cases as possible, regardless of being paralytic poliomyelitis or not. As a result of the provincial team's field investigations, it was considered that a number of unreported cases of poliomyelitis might have existed in areas where outbreaks had occurred before 1991. Reasons for the under reporting were complex but it was caused sometimes by simple negligence by local staff or diagnostic errors because of very mild neurologic signs. Another important aspect of polio surveillance is speed of case reporting. Although in 1991, general achievement of AFP immediate reporting was not satisfactory, monitoring by several surveillance indicators in the later half of this year showed a small but clear improvement in the overall intervals between onset of AFP and investigation by county EPS (data not shown).

Of 231 cases reported as AFP, nearly half of the children were either normal or presented miscellaneous signs which had nothing to do with AFP. It is therefore suggested that improvement of the specificity of AFP surveillance would be required as the second step. Special training may be needed to improve skills of local staff to investigate cases. Recently, McKhann et al. (12) reported epidemics of a GBS-like paralytic illness in Hebei, which shares a border with Shandong province. This syndrome should be included for consideration for the differential diagnosis of AFP.
As a conclusion, polio surveillance provides crucial information for establishing strategies of polio eradication. Shandong province carried out a second OPV mass immunization campaign starting in December, 1991 and the data obtained from our new surveillance system served as the basis for determining the details of the campaign.

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REFERENCES