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POLIOMYELITIS

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Epidemiology

Only about 1 per cent of susceptibles exposed to a wild poliovirus will show a recognized clinical manifestation. In other words the great bulk of poliovirus infections are completely silent and symptomless. Epidemiologically (a) an absence of paralytic cases does not necessarily mean that polioviruses are not circulating in the community, and (b) a paralytic case may represent a solitary event without an apparent source of infection.

The clinical manifestations include

- mild illness, e.g. fever, malaise;
- aseptic meningitis, poliovirus is only one of many viruses that cause aseptic meningitis;
- paralytic poliomyelitis, paralytic disease may occur in other enterovirus infections but is rare and usually transient

Virus-neutralizing antibodies form within a few days after exposure and persist apparently for life. The virus multiplies in the intestinal tract and deep lymphatic structures. Antibodies must be present in the blood to prevent the dissemination of the virus to the central nervous system - they are not effective if CNS has already been invaded.

Passive immunity is transferred from mother to offspring, but the maternal antibodies gradually disappear within the first six months of life. Local (or cellular) immunity, though little understood, is increasingly recognized as having an important role in protection against infection.

Man is the only known reservoir for the polioviruses. The mouth is the portal of entry and primary multiplication takes place in the oropharynx and intestines. The virus is regularly present in the throat and in stool before the onset of illness. There is little or no virus in the throat within a week from onset but the virus continues to be excreted in faeces for several weeks, even in the presence of high antibodies in the blood. Faecal contamination is the usual source of infection. Polioviruses are readily spread within the family.

Poliomyelitis in the world

"Infantile" poliomyelitis. In the developing world where no organized immunization programmes have been instituted poliomyelitis continues to be a disease of infancy, i.e. actually "infantile paralysis". The majority of countries report only a small number of sporadic cases. Mothers, universally immune to all three types of poliovirus transfer their immunity to their offspring. The polioviruses are circulating intensively in the community. Infants are exposed to the wild polioviruses while still under cover of maternal antibody protection. The ratio of inapparent to apparent infection is highest in infants. The end result is a picture of very high and very early infection with hardly any or no paralysis.

However, in recent years in a number of instances a high toll of infantile paralysis has been coupled with wide circulation of the virus. There was no evidence of epidemics in recent years in Ghana, but in 1974 the observed prevalence of lameness attributed to poliomyelitis was 7 per thousand among school-age children and the annual incidence was estimated to be at least 28 per 100 000 population. These figures are comparable to those prevalent in North America and Europe prior to the introduction of the vaccine.

Epidemic poliomyelitis. In a number of developing countries suddenly poliomyelitis hits in the form of an extensive outbreak. To cite only a few, there is the classical example of Argentina where suddenly more than 400 laboratory-confirmed paralytic cases occurred in 1971. There is again the example of Malaysia where an incidence of a little over 100 cases was recorded during the sixties and then a sudden outbreak extended over 1971/1972 and accounted for more than 1200 laboratory-confirmed paralytic cases. Only recently, i.e. early this year, the Philippines experienced the first outbreaks of paralytic poliomyelitis. Payne has stipulated that when the general conditions of the population improves as evidenced by the dropping of infant mortality below 75 per 1000 live births, the incidence and pattern of poliomyelitis changes. Thus poliomyelitis outbreaks may be the unwelcome concomitant of improved living standards in the developing world.

"Controlled poliomyelitis". In Europe, North America, Oceania and in some other areas of the world the possibility of effective control of poliomyelitis became a fact in 1955. In that year killed poliomyelitis vaccine was introduced. The reduction in the annual incidence of poliomyelitis was further accelerated in 1959-61 when the live attenuated vaccine became available on a large scale. In 1955, 17 364 cases of poliomyelitis were reported in the USSR, 27 343 cases in the other countries in Europe, and 31 582 in the United States of America, Canada, Australia and New Zealand combined - a grand total of more than 76 000 cases. In the same countries in 1967 only 1013 cases were reported, i.e. a reduction of over 98 per cent. in 12 years. The reduction has since been maintained and the number of cases reported in 1975 in the same countries was less than 300. However, recently in a few countries coverage by immunization has been on the decline and the number of poliomyelitis cases among the non-vaccinated has increased, although still very small in number. In one country, with over 50 million population where not more than three or four cases were recorded annually, over 12 cases were reported in 1976 and in 1977 14 cases were reported during the first eight months of the year. At the same time vaccination coverage has been decreasing by approximately 10% per year and is estimated to be not more than 60% at present.

Concomitantlyin a few areas with repeated vaccinations conducted regularly and reaching virtually all young children, wild polioviruses were rarely identified. In other words the poliovirus strains isolated in these areas now closely resemble the attenuated vaccine strains and are generally presumed to be of vaccine progeny. Vaccine viruses are abundantly excreted by the vaccinee and are infecting the unvaccinated contacts. The rare cases of poliomyelitis that do appear are attributed to imported wild viruses or may be in some instances vaccine-associated.

Poliomyelitis surveillance

The aims of a surveillance programme can be summarized as follows:

1. Assessment of incidence and trends of poliomyelitis-related morbidity and mortality

(a) In countries conducting control (immunization) programmes, data on disease attack rates in various sectors of the community provide the primary tool for evaluating programme efficacy. By collecting case data according to vaccination status (fully vaccinated, partially vaccinated, not vaccinated, unknown) this surveillance system also provides a check on vaccine safety and efficacy. In developed countries where oral poliomyelitis vaccine is used extensively and poliomyelitis attack rates have been reduced to extremely low levels, and where also sophisticated investigation of viruses is feasible, the primary focus will be on vaccine safety and in establishing the relationship, if any, between the viruses isolated from paralytic cases and those being used in the vaccines.

In countries in which poliomyelitis incidence has not yet been effectively reduced, the numbers of cases will preclude this type of detailed analysis, and the primary focus will be on identifying clusters of cases in persons thought to have been fully immunized as a check on vaccine potency.

(b) In countries not conducting control programmes the magnitude of the disease problem has to be assessed. Residual paralysis is relatively easily recognized, and a survey of groups such as pre-school children or school entrants can give a reliable indication of the extent of the problem and the need for an immunization programme.

(c) In both countries with and without control programmes, the disease surveillance system provides an early warning of large outbreaks, and when such data is placed before national and/or international decision-makers promptly, it can lead to co-ordinated purposeful interventions being undertaken to control further disease spread.

2. Assessment of vaccination coverage and immune status of the population

(a) Countries with control programmes: focus is laid on immunity as provided by vaccination, sero-conversion rates and duration of immunity in various age-groups. However, in a number of countries there has recently been a trend of diminishing interest in vaccination and the need has arisen to determine periodically the immunity profiles in different ages and sectors of the community.

(b) Countries without control programmes: sample serological surveys carried out in the sectors of the community which risk lacking protective antibodies would detect potential areas for epidemics. Serological findings provide information to be used when planning to undertake a control programme.

A survey of an unvaccinated population can help define both the extent and the age distribution of the disease. In other words the information will assist in determining the vaccination schedule, i.e. designing a schedule that will provide a complete course of vaccination before a high percentage of children have been exposed to the wild virus.

In this context it is to be noted that in the developing world, even in countries where poliomyelitis is shifting into an epidemic form, the disease is still seen in the very young. 70 to 80 per cent. of cases occur in the first two or three years of life and 80 to 90 per cent. by the end of the fourth year

Poliomyelitis vaccines

Both "killed" (Salk-type) and "live" (Sabin-type) are available. The killed vaccine is administered by injection and the live vaccine is given orally. Both killed and live vaccines have been used widely and both have shown to be safe and effective.

1. Killed poliomyelitis vaccine

The vaccine is prepared from polio viruses grown in monkey kidney culture and is inactivated by formalin. It came into use in 1955 but gave way in most countries to the live vaccine when this was later introduced. It is still used in Finland, Sweden, Holland, some parts of Canada and Australia. In Denmark two doses of killed vaccine are given before feeding live vaccine

The advantages and disadvantages of the killed poliomyelitis vaccine can be summarized as follows. Properly prepared and administered it induces good levels of humoral antibodies in a satisfactory proportion of those receiving sufficient doses, and thus protects the vaccinee against paralytic poliomyelitis. In the countries where it has been exclusively but extensively used, it appears to have cut short the circulation of polioviruses. However, this has been observed in small countries which have been providing repeated doses to nearly the entire target population and are furthermore surrounded by countries where there has been effective control (by live vaccine) for a long time.

The killed vaccine can be included in the combination diphtheria-pertussis-tetanus vaccine and can thereby be incorporated into the immunization schedule for infants and young children. Nonetheless, generally repeated reinforcing doses are required to keep up the immunity.

The absence of living virus excludes the potential for mutation and reversion to virulence. But by the same token the vaccine does not induce local (intestinal) immunity in the vaccinee; hence wild viruses can multiply in the gut of the vaccinees. In other words the vaccinees do not serve as a block to infection with the wild viruses.

The absence of living virus permits its use in individuals with immunodeficiency diseases or those under immunosuppressive therapy, and their families.

The biggest disadvantage, however, is the difficulty in producing large amounts of vaccine in sufficiently high virus titres. Concomitantly, the cost of the killed vaccine is much higher than the live vaccine.

Although the killed vaccine has had a very good record, if a single failure in virus inactivation were to occur the use of virulent polio viruses as vaccine seed creates potential for tragedy, especially if the vaccine is to be produced by a multitude of firms on a large scale.

However, attempts are at present being made on the one hand to grow viruses in very high titres in human diploid cells, and on the other hand, to prepare a sub-unit vaccine.

2. Live poliomyelitis vaccine

The live poliomyelitis vaccine is prepared from the Sabin virus strains obtained by attenuation of the polioviruses by serial passage in tissue culture. The vaccine was first produced in 1955. Large-scale field trials were carried out in 1955-1959 which established its safety and efficacy Many countries used it for routine immunization in 1960 and it was licensed in the United States of America in 1961-62. When first used (and until recently in many Socialist countries) monovalent vaccines each incorporating a serotype were commonly used. However, trivalent vaccine is now widely used.

The live attenuated poliomyelitis vaccine is given by the oral route. It infects, multiplies and immunizes, i.e. it simulates the natural polio virus infection. It confers long-lasting immunity, possibly lifelong. By colonizing the intestinal tract it competes with and induces resistance to infection by the wild polioviruses In other words it blocks the circulation of the poliovirus in the community.

In the face of an epidemic live vaccine can be easily administered on a mass scale and quickly halts the epidemic. As the live vaccine viruses become established quickly in the gut of the vaccine recipients, they are capable of blocking infection with the epidemic virus within a matter of days, even before the vaccine-induced antibodies can become fully effective.

One advantage of the live poliomyelitis vaccine is the ease with which it is grown in tissue culture and the quantity in which it is produced. The price is thereby much lower than that for the killed vaccine. Furthermore, recently, human diploid cell cultures have been licensed for vaccine production, this economises on the use of monkeys which are becoming scarcer every day and also ensures freedom from viral contamination.

Live vaccine is sensitive to heat and has to be maintained cold, preferably below zero. Magnesium chloride and sucrose are good stabilizers but do not obviate the need for rigorous cold storage and transport.

In the developing world seroconversion rates have been lower than those observed in Europe or North America. This has been attributed to antibodies in the mother's milk, interference by other viruses, especially the enteroviruses, and recently to an inhibitory substance in the saliva. However, three doses of a potent vaccine assure a good immunity in most instances.

In rare cases live poliomyelitis vaccine has been associated temporally with paralytic disease in vaccine recipients or their close contacts. The findings of a WHO collaborative study on the relation between acute persisting spinal paralysis and poliomyelitis vaccine confirms that oral Sabin vaccines are among the safest vaccines in use today.

Both killed and live poliomyelitis vaccines are effective in preventing poliomyelitis, but TOPV is easy to administer, confers more resistance in the alimentary tract to reinfection with poliovirus and interferes with simultaneous infection with wild viruses, and is therefore more suited to organized community-wide vaccination programmes and epidemic-control campaigns. Furthermore, primary vaccination with live poliomyelitis vaccine produces long-lasting immunity.

Because of the above most of the countries have adopted the live vaccine for their national routine immunization programmes.

Vaccination schedule

1. Killed vaccine. Four doses should be given for primary immunization The first three doses should be combined with DPT, i.e started during the second or third month of life and given at 4-6 week intervals. The fourth dose is given 6-12 months after the third and reinforcing doses are given at 2-3 year intervals, but probably at longer intervals with the more potent vaccines available.

Killed vaccine should be given to persons with immunodifficiency diseases. It is preferable to give killed vaccine rather than live vaccine to pregnant women or to those who are under immunosuppressive therepy. There is no no known contraindication except apparent severe febrile disease.

2. Live vaccine. Three doses of trivalent live vaccine should be given for primary immunization. Again they should be integrated with DPT vaccination. In countries where vaccination programmes have been carried out effectively for long periods, a reinforcing dose may be given upon school entry.

In addition to the usual apparent severe febrile disease the contra-indications to the live vaccines are immunodifficiency diseases and immunosuppressive therapy.