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The case for global eradication of poliomyelitis

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Global eradication of poliomyelitis can be achieved by a programme strategy that includes achievement and maintenance of high immunization levels, effective surveillance to detect all new cases, and a rapid vigorous response to the occurrence of new cases. Regional eradication targets have already been set in Europe and the Americas. Possible impediments to eradication include the necessity to generate political and social will; managerial constraints; issues of vaccine efficacy, stability, and cost; and adequacy of surveillance. We believe that the impediments can be overcome and that with intensified effort and increased international collaboration, global eradication could be achieved as early as 1995.

INTRODUCTION

Although paralysis similar to that caused by poliomyelitis has been reported since ancient times, epidemic poliomyelitis was first recorded in northern Europe late in the nineteenth century (1). During the first half of the twentieth century, epidemic waves of increasing magnitude were seen in industrialized countries, with tens of thousands of cases and thousands of deaths reported annually. In the USA, a peak incidence of 13.6 per 100 000 population was reported in 1952, representing 21 269 cases of paralytic disease (2).

For many years, poliomyelitis was considered to be primarily a problem of highly developed countries. Classical theory suggested that, in developing

countries, infants would be exposed to polioviruses while still protected by maternally-derived antibodies and would thus develop immunity without paralysis. As personal and community hygiene improved, early exposure would be less common, allowing accumulation of groups of susceptibles and making it possible for epidemics to occur. In the past 15 years, however, a number of studies have shown that poliomyelitis is a worldwide problem. The prevalence of lameness due to poliomyelitis in children in developing countries is in the order of 5 cases per 1000 population (range: 0.5-19), suggesting an incidence similar to that seen in developed countries during the pre-vaccine era (3). Paralytic poliomyelitis in the developing world is primarily a disease of infants and very young children. Since exposure occurs at a very early age preventing the build-up of large groups of susceptibles, poliomyelitis usually occurs endemically. The World Health Organization estimates that more than 250 000 cases of paralytic poliomyelitis occur each year worldwide.^a

The introduction and widespread use of inactivated

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^a EXPANDED PROGRAMME ON IMMUNIZATION. *Global overview*. Unpublished WHO document EPI/GAG/86/WP 1, 1986.

poliovirus vaccine (IPV) in 1955 and live, attenuated oral poliovirus vaccine (OPV) in 1961 had a dramatic impact on the reported incidence of poliomyelitis in the USA and other developed countries (3). Immunization programmes in which very high levels of coverage with IPV were achieved have been responsible for the disappearance of poliomyelitis from Iceland, Sweden, and some provinces in Canada, as well as its virtual disappearance from Finland and the Netherlands. Similar successes have also been achieved in Cuba, Czechoslovakia, the USA and several other countries, where extensive use of OPV appears to have interrupted the circulation of wild polioviruses. A primary series of either IPV or OPV generally induces seroconversion against all three types of poliovirus in more than 90% of recipients: available evidence indicates that the resultant clinical protection is long-lasting, and probably lifelong (3).

DEVELOPMENT OF THE ERADICATION CONCEPT AND STRATEGY

Given the continued burden of poliomyelitis in much of the world and the marked success in control or elimination of the disease in developed countries using either IPV or OPV, interest has arisen in the possibility of eradicating poliomyelitis (3, 4). We define eradication as the interruption of transmission of a disease (and the elimination of the causative agent) from a sizeable geographic unit with such a low risk of reintroduction of the agent from other areas that preventive measures (e.g. immunization) are no longer required; surveillance and prompt response to importation are capable of maintaining these areas free of disease. As with smallpox, certain factors favour the eradication of poliomyelitis, including the observations that wild-virus infection results in lifelong immunity; that there is no long-term carrier state; that there is no non-human reservoir of infection; and that effective vaccines are available for prevention (3). The 31 countries of the WHO European Region have established a target of elimination of indigenous poliomyelitis by the year 2000 (5), and the 46 countries and territories of the WHO Region of the Americas (acting through the Pan American Health Organization (PAHO)) have set a target of eradication by 1990 (6). We believe, however, that global eradication is a more appropriate goal to consider. Furthermore, the eradication effort can also serve as a model for strengthening the development of general immunization and primary care services throughout the world. Eradication can be achieved by a programme strategy which includes the following components.

(1) *Achievement and maintenance of high immunization levels*

Based on the experience in developed countries, the administration of polio vaccine to a high proportion of children under one year of age will be the most crucial step in the initial phases of eradication. The exact level of coverage needed is unknown but is certainly in excess of 80%—countries in which poliomyelitis has been eliminated have typically achieved coverage in the order of 90%. OPV is currently considered the vaccine of choice in developing countries since it is readily available, inexpensive, and does not require knowledge of injection techniques or equipment for administration. OPV also offers several distinct advantages over IPV, in that it can spread to close contacts of the vaccinee, thereby extending protection, and it often induces local intestinal immunity which impedes the ability of the recipient to spread wild poliovirus on subsequent exposure. In addition, OPV is capable of interrupting the transmission of wild polioviruses and other enteroviruses when administered simultaneously to a large number of persons in a community. On the other hand, the availability of an improved, more potent IPV since the late 1970s offers the advantages of nearly universal seroconversion after only two doses and elimination of the small risk of paralysis associated with OPV. Pilot projects are currently under way to study the feasibility and efficacy of such a programme in developing countries. In addition, a combined schedule of OPV and IPV is also being used or considered in some countries, particularly in view of the success of this strategy in the Gaza Strip (3).

Strategies to achieve the necessary immunization coverage will obviously differ depending on the health-care infrastructure and availability of resources in each country. Programmes employing routine immunization schedules have brought about dramatic reductions in paralytic poliomyelitis in several developing countries. However, in many developing countries, routine health services have been shown to be inadequate to achieve satisfactorily high levels of vaccine coverage, so that a special strategy, the use of National Vaccination Days (NVD), has evolved. The most dramatic example of this approach has been in Brazil (7), where repeated epidemics occurred in the face of moderately successful routine immunization programmes. In 1980, a series of NVDs was begun, with major use of broadcast and printed media to orient the population to the need for polio immunization for all children less than 5 years of age. On a single day, OPV was administered to more than 20 million children by 300 000 lay volunteers at some 90 000 immunization posts distributed throughout the country. NVDs have

since been held twice a year, and were associated with a reduction in the incidence of paralytic disease to less than 1 case per 100 000 by 1984. A similar, but more regional approach ("pulse" immunization) has also proved to be successful in India (8). NVDs will probably serve as the principal strategy for use in polio-infected countries, while improvements in ongoing services may be all that is required in countries which are currently polio-free.

(2) *Effective surveillance to detect all new cases*

In addition to achieving and maintaining high immunization levels, the development of effective surveillance systems will be critical. Such systems are essential to define the extent of the problem and to guide control efforts. Special efforts must be made to determine whether cases represent failure of the vaccine delivery system or failure of the vaccine itself. To obtain critical information the surveillance systems must involve all institutions and medical-care providers who are likely to see suspected cases of poliomyelitis, and there should be regular (including negative) reporting from each site. The functioning and standardization of such systems can be facilitated by the adoption of uniform case definitions such as those used in the Americas (9).

In addition to this clinically and epidemiologically based surveillance system, laboratory-based systems must also be developed, at least on a regional basis. Laboratory diagnosis will be important not only in identifying which types of poliovirus are currently circulating in a given country or region but also in distinguishing vaccine-virus from wild-virus. The application of more sophisticated techniques such as nucleotide sequencing will also allow investigators to determine the geographical origin of each isolate, so that special efforts can be directed towards control of poliomyelitis in countries which continue to serve as endemic foci of wild virus infection.

(3) *Rapid and vigorous response to the occurrence of cases*

In view of the high infection-to-case ratio in poliomyelitis, the occurrence of a single case should be considered as equivalent to an epidemic. Thus, every individual with acute onset of paralysis must be reported to the appropriate health authority and investigated within 24 hours of notification. If the ensuing investigation reveals that paralysis is flaccid and there is no other proven cause (i.e., a "probable" case of poliomyelitis), the case should be reported to the national level and outbreak control measures should be undertaken in a sizeable geographical/epidemiological area around the case. These measures should include a search for additional cases, the

assessment of immunization levels, and rapid immunization of all children in the area. Usually all children less than 5 years of age should be immunized, but epidemiological circumstances may indicate a broader age range should be targeted.

The fact that outbreak control measures have repeatedly been able to contain outbreaks has strong implications for our ability to achieve and sustain regional eradication on the way to global eradication. Although outbreaks of poliomyelitis have occurred among pockets of unvaccinated individuals in well immunized populations (e.g., in the Netherlands and USA), there was no spread of disease outside these localized communities. These observations further illustrate the effectiveness of high levels of immunization in preventing spread throughout the general population, whether the vaccine used was IPV (as in the Netherlands) or OPV (as in the USA) (3).

POSSIBLE IMPEDIMENTS TO ERADICATION

In spite of the dramatic success of immunization programmes in eliminating or controlling wild poliovirus infection in nearly all industrialized countries and in some areas in the developing world, a number of impediments must be addressed and overcome before eradication can be achieved.

Political and social will. Obviously, no undertaking as ambitious as global eradication of a disease can succeed without political commitment and social and financial support. Political support has already been demonstrated in the WHO European and American Regions by the adoption of regional eradication targets by the Ministers of Health of Member States (5, 6). Similar support must be sought from the other nations of the world. The public support and social mobilization achieved through National Vaccination Days indicate a receptive public attitude. Financial support must come both from within countries (the vast majority) and from external sources. In recent years, additional external resources have been made available to the Expanded Programme on Immunization (EPI), with notable contributions by UNICEF and other multinational governmental agencies, several individual governments (including those of Canada, Italy, and the USA), and Rotary International. The latter organization has made a commitment to provide all of the polio vaccine necessary for any country for a period of 5 years in order to bring about polio eradication. Consequently, it appears that these impediments may be removed.

Managerial constraints. Mid-level management (including logistics, maintenance, supervision, etc.)

is the major constraint facing poliomyelitis eradication as well as all other health programmes in the developing world. These problems are being addressed on a number of fronts: extensive training sessions have been held involving thousands of participants, simplified equipment has been developed to maintain the "cold chain" of refrigeration necessary to ensure vaccine potency, and manuals and guides have been developed and widely distributed. The poliomyelitis eradication programme will provide a further boost towards resolution of these constraints.

Vaccine efficacy, stability, and cost. While OPV has been highly effective in developed countries, its performance in some tropical regions has been considerably lower than expected. Part of this problem can be explained by a loss of potency when the vaccine is exposed to heat, and this can be overcome by training programmes and use of appropriate equipment. However, even when the vaccine is properly managed and its potency maintained, several instances of failure to seroconvert after receipt of three doses have been reported (3). Outbreaks related in part to such circumstances occurred in north-east Brazil (10) and the Gambia (11) in 1986. Of equal concern are instances in which outbreaks of poliomyelitis have occurred in spite of successful immunization programmes. A large outbreak in China (Province of Taiwan) in 1982, for example, indicated that poliovirus could successfully infect unvaccinated individuals in the face of OPV immunization levels in the general community of approximately 80% (12). These and other observations underscore the need for additional research to establish the optimal formulation and schedule of OPV in tropical countries. Several such studies are currently under way or in the planning phases.

Because the improved, more potent IPV is more heat-stable than OPV, and since two doses have been shown to induce seroconversion in virtually 100% of recipients (3), consideration is currently being given in several developing countries to using this vaccine either alone or in combination with OPV. However, the current production capacity for IPV is relatively limited, its cost remains relatively high (approximately 30 times that of OPV), and its administration requires more highly trained personnel than does OPV. While preliminary investigation of an outbreak of paralytic disease in Senegal raised concerns about the clinical efficacy of IPV in the developing world, further studies indicated that the outbreak resulted because of low vaccine coverage (13).

Adequacy of surveillance. A number of developing countries lack a well organized health-care infrastructure, trained epidemiologists, laboratory

support, and adequate ancillary resources. These deficiencies are at present being tackled, but still pose considerable obstacles for developing a sensitive surveillance system to rapidly detect new cases of poliomyelitis. Experience has also shown that physicians may be reluctant to diagnose poliomyelitis in the face of high levels of immunization, and may attribute acute paralysis to other conditions such as Guillain-Barré syndrome. However, these and other problems that have surfaced in the Americas are being dealt with by intensive training programmes, as well as temporary assignment of qualified consultants to countries in need of assistance in establishing surveillance systems. These efforts will also serve to strengthen epidemiological and programmatic expertise in many other programme areas.

COMMENT

The Expanded Programme on Immunization (EPI) was initiated by the World Health Organization in 1977 with the goal of providing immunizations for all the world's children by 1990, polio vaccine representing only one of six antigens used. As of 1987, worldwide coverage of 1-year-old children with 3 doses of polio vaccine was estimated to be only approximately 50%, but an estimated two-thirds of children had received at least one dose.^b The increased external support for the EPI mentioned above and the accelerating pace of the EPI gives hope that the target of universal access to immunization by 1990 will be achieved. In view of this progress, consideration should be given to the additional investment of personnel and finances required to achieve the coverage and surveillance necessary to eradicate poliomyelitis. Formal benefit-cost studies of global eradication have not been carried out. However, such a study of the poliomyelitis eradication programme in the Americas clearly indicated that the benefits of regional eradication will outweigh the costs, even if the analysis is restricted to direct costs of care alone (P. Musgrove, personal communication, 1987). In addition, it must be remembered that the benefits from eradication will be perpetual while the costs will be temporary.

Even though the administration of OPV in routine immunization services has not had an optimal effect in several tropical countries, the experience in a few countries indicates that National Vaccination Days can have a major impact on the incidence of disease. Research to identify improved schedules or formulations of existing vaccines will be of great assistance in enhancing the impact of ongoing as well as intensified programmes.

^b EXPANDED PROGRAMME ON IMMUNIZATION Global status report. *Weekly epidemiological record*, 62 (33). 241-243 (1987).

Notwithstanding the impediments noted above, the general experience with polio vaccines has been very positive and it appears that the main considerations in achieving poliomyelitis eradication are operational. In many developing countries, the routine health services have not been able to achieve a sufficiently high level of coverage and the special technique of National Vaccination Days has evolved. It is not yet clear if or how these intensive efforts will lead to sustained routine immunization services. None the less, they clearly offer the opportunity for short-term gains which can help change social expectations. If such impressive gains can be made in the short run, should a society settle for less in the long run?

If current efforts can be enlarged and sustained, disease due to wild poliovirus can be eliminated. Problems that will then arise relate to documenting the absence of wild virus transmission and eliminating the small number of cases of OPV-associated disease. Laboratory innovations give promise that simplified techniques will be developed to allow easy characterization of polioviruses recovered from individuals or from sewage. Elimination of vaccine-associated disease may await discontinuation of

routine polio vaccination or might be accomplished earlier through an increasing use of IPV, either alone or in combination with OPV.

Poliomyelitis eradication can serve as the "banner" around which to rally the activities of the EPI. In addition to the long-term health benefits which will be realized by eradication of poliomyelitis, other benefits will include refocusing efforts from simply achieving coverage to controlling the disease and measuring the programme's impact. In addition, there will be enhancement of other immunization activities, improvements in surveillance, improvements in laboratory facilities, and the development of a group of trained epidemiologists who can be of assistance in other important health programmes.

Global eradication of poliomyelitis is inevitable; the only question is whether we will accomplish it or pass on the needed action to our successors. We believe we should act now to leave the legacy of a poliomyelitis-free world for our children. With intensified effort and increased international collaboration, global eradication could be achieved as early as 1995.

RÉSUMÉ

POUR UNE APPROCHE MONDIALE DE L'ÉRADICATION DE LA POLIOMYÉLITE

En l'absence de vaccination, la poliomyélite paralytique est endémique ou épidémique dans le monde entier. L'introduction et l'emploi généralisé du vaccin antipoliomyélitique inactivé (VPI) au milieu des années 50 et du vaccin antipoliomyélitique buccal (VPO) au début des années 60 ont eu un impact considérable sur la poliomyélite dans les pays industrialisés: nombre d'entre eux sont parvenus à interrompre la transmission du virus poliomyélitique sauvage. On estime néanmoins qu'il se produit encore plus de 250 000 cas de poliomyélite paralytique chaque année, dont l'immense majorité dans les pays en développement.

Des cibles régionales ont été fixées en Europe et aux Amériques pour l'éradication de la poliomyélite. L'éradication mondiale nous semble être un but plus approprié qui pourrait être atteint à l'aide d'une stratégie alliant la réalisation et le maintien de niveaux de vaccination élevés, une surveillance efficace pour le dépistage de tous les cas nouveaux et une intervention énergique et rapide lors de l'apparition de cas nouveaux. Dans de nombreux pays, des stratégies accélérées telles que des journées nationales de la vaccination pourront être nécessaires pour atteindre les niveaux de vaccination nécessaires.

Divers facteurs pourraient freiner l'éradication, ainsi par exemple la nécessité de susciter une volonté politique et sociale, des contraintes d'ordre gestionnaire, les problèmes liés à l'efficacité, à la stabilité et au coût du vaccin et, enfin, la qualité de la surveillance. L'expérience montre qu'un

appui politique peut être obtenu; il en est de même du soutien social et financier. Les principaux obstacles sont d'ordre gestionnaire mais on s'efforce de les surmonter sur divers fronts. Les obstacles liés à l'efficacité, à la stabilité et au coût du vaccin ne sont pas insurmontables. La surveillance est actuellement insuffisante dans la plupart des pays en développement mais on s'emploie à mettre au point des techniques de surveillance efficaces (y compris l'appui de laboratoire nécessaire). Nous croyons donc qu'il est possible d'éliminer ces obstacles.

L'éradication de la poliomyélite peut servir de ralliement pour toutes les activités du Programme élargi de vaccination. Outre les bienfaits à long terme qui résulteront pour la santé de l'éradication de la poliomyélite, les autres avantages seront notamment les suivants: les efforts jusqu'à présent consacrés à la simple couverture vaccinale pourront être axés sur la lutte contre la maladie et l'évaluation de l'impact du programme; les autres activités liées à la vaccination bénéficieront d'un rang de priorité plus élevé; la surveillance ainsi que les installations de laboratoire pourront être améliorées et, enfin, un groupe d'épidémiologistes qualifiés pourra être créé et prêter son concours à d'autres programmes de santé importants.

L'éradication mondiale de la poliomyélite est inévitable. Grâce à l'intensification des efforts et au renforcement de la collaboration internationale, elle pourrait être réalisée dès 1995.

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