Eradication of smallpox ranks as one of medical science's greatest contributions to public health, saving millions from disease and eliminating the need for vaccination. The World Health Organization (WHO), in cooperation with the Centers for Disease Control and Prevention (CDC), Rotary International, and governments around the world, is in the process of completing another such accomplishment, but in a considerably different social climate and with a different pathogen. The worldwide effort to eradicate polio is likely to reach its goal by 2003, if current levels of funding and cooperation continue. While we applaud this goal and the progress that has been made, we feel that the crucial final steps in the campaign need to be reconsidered.

The WHO has implemented a plan that takes advantage of the seasonal nature of poliovirus spread. National Immunization Days (NIDs) are held during the winter, or "polio-low season." They involve massive publicity campaigns, followed by door-to-door visits to unvaccinated households. Additional doses of the vaccine are distributed as needed during the "high season," when outbreaks occur. This approach maximizes the effect of vaccination and bypasses many of the logistical difficulties of a year-round effort. The eradication campaign uses live Sabin oral polio vaccine (OPV) exclusively, because it is cheaper than inactivated polio vaccine (IPV) and does not require trained personnel and sterile needles (1), resources which many lesser developed countries lack.

The WHO also rigorously tracks cases of infantile paralysis and screens sewage and river water for poliovirus in targeted areas. Whenever an outbreak is detected, a local immunization campaign is carried out to prevent the virus' spread (2). The results of the eradication effort have been impressive. Poliomyelitis caused by wild-type poliovirus (wild polio) is rapidly vanishing from even the most remote regions worldwide. The CDC projects that the world will be polio-free by 2003 (3), leaving behind a medical infrastructure for vaccination that can then be used in a campaign against measles. Under this plan, polio vaccination will be stopped by 2005, which will save about $200 million a year in vaccine-associated expenses in the U.S. alone (3). After this date, laboratory stocks of poliovirus
virulent forms (4), potentially pathogenic viruses are still being released into the aquifers. Vaccine-associated poliomyelitis will still occur in these "polio-free" areas, at rates of 1 in 300,000 (5) to 1 in 500,000 (6) recipients of OPV. Because recycling of waste water is necessary in many parts of the world, virus excreted by vaccinees may persist indefinitely (7).

A broader, more intuitive definition of eradication would be elimination of both vaccine and wild strains--a goal that cannot occur if only OPV is used. Difficulties in distribution and lack of medical resources are cited as reasons for using OPV, but terminating the effort without making a transition to IPV contradicts the WHO goal of establishing an infrastructure for future eradication campaigns. One way to accomplish both goals would be to continue polio vaccination until IPV can be distributed worldwide. Then the campaign would not be an isolated effort, but part of a broader public health initiative (8).

Before vaccination can be stopped safely, it will be necessary to destroy most existing viral stocks and restrict access to the remainder to prevent accidental and deliberate release. For smallpox, virus stocks were located in only a few institutions before eradication, which meant that inventory control was relatively straightforward. There is no central record of poliovirus stocks, which are distributed among hundreds, or possibly thousands, of sites. Without an accurate inventory, it is unlikely that all virus stocks can be found and destroyed. For example, during structural studies of coxsackievirus B1, an enterovirus, it was discovered that the virus stock was contaminated with polio (9). This incident emphasizes the difficulty in identifying poliovirus repositories in research laboratories. Experience with influenza virus suggests that accidental release of an infectious agent from laboratory stocks may occur (10). As with smallpox, there is the possibility that some wild virus will survive for long periods in the environment (11, 12). Even if total virus destruction could be accomplished, the small size of the poliovirus genome (7.5 kb), whose sequence is known (13, 14) and whose complementary DNA is infectious (15), would make it possible for a terrorist to synthesize a new stock.

In the post-vaccine world, the susceptible population would increase each year and the large number of potential sources of reintroduction would soon constitute a major threat. Vaccination of laboratory personnel who are studying the virus or maintaining emergency vaccine stocks then creates a dilemma. If workers are vaccinated with OPV, they will shed live poliovirus into the environment. Use of IPV would allow these workers to act as carriers (because infection of the gut is still possible), increasing the probability of an outbreak. For smallpox, the fact that vaccine and virulent strains differ substantially made it possible to avoid this difficulty.

To evaluate the potential impact of a single reintroduction of poliovirus into the post-vaccine world, we can use the 1992-93 Dutch epidemic as a model. In this incident, 67 cases of paralytic poliomyelitis were reported, but the virus spread to many more individuals. High levels of vaccination with IPV meant that the paralytic cases were restricted almost entirely to members of a religious group that
refused the vaccine (16). Within this subpopulation and its immediate contacts, the virus spread very efficiently; ~7% of the children in this group were actively secreting wild polio in a single sampling taken during the epidemic (17). This epidemic occurred in a nation with high standards of health care, where paralytic cases were reported promptly and additional doses of IPV and OPV were distributed to the affected area immediately. Such high standards of preparedness are unlikely to continue after cessation of vaccination. In a city of 10 million unvaccinated individuals, a rough estimate would be that a single release of virus could result in 7000 paralytic cases. It would take more than 700 years of vaccination to produce that number of cases of vaccine-associated paralysis in the U.S.

The control of poliomyelitis has substantially improved the quality of life worldwide, and the completion of this task will allow lesser developed countries to focus on other public health issues. To succeed, however, the polio eradication effort should take a balanced approach as part of a larger campaign to improve health and sanitation.

REFERENCES

9. E. Arnold, personal communication.