Commentary

A Ten-Year Experience in Control of Poliomyelitis through a Combination of Live and Killed Vaccines in Two Developing Areas

THEODORE TULCHINSKY, MD, MPH, YEHIA ABED, MD, MPH, SAID SHAHEEN, MD, NADIM TOUBASSI, MD, YITZCHAK SEVER, MD, MICHAEL SCHOENBAUM, BA, AND RACHEL HANDSHER, MSc

Abstract: We describe a successful program of poliomyelitis control using a combination of killed and live polio vaccines over a 10-year period in two developing areas, the West Bank and Gaza, adjacent to a relatively developed country, Israel. During the 1970s, immunization using live trivalent oral polio vaccine (OPV) in these areas covered more than 90 percent of the infant population. Nevertheless, the incidence of paralytic polio continued to be high, with many cases occurring in fully or partially immunized persons. It was thought that this could be due to interference with OPV take by other enteroviruses present in the environment due to poor sanitary conditions in these areas. A new policy combining five doses of OPV with two doses of inactivated polio vaccine (IPV) was adopted and implemented in 1978. In the 10 years since then, immunization coverage of infants increased to an estimated 95 percent and paralytic poliomyelitis has been controlled, despite exposure to wild poliovirus from neighboring countries including an outbreak in Israel in 1988. This experience suggests that wide coverage using the combination of IPV and OPV is an effective vaccination policy that may make eradication of polio possible even in developing areas. (*Am J Public Health* 1989; 79:1648–1652.)

Introduction

The West Bank is located between Israel and Jordan, and Gaza lies between Israel and Egypt (see map). Israel has governed these areas since June 1967. Prior to that, the West Bank was administered by Jordan, and Gaza was under Egyptian rule. In 1988, the Palestinian population of the West Bank was estimated at 887,000, and that of Gaza was 600,000.[1–4] Population density in the West Bank is about 155 residents per square kilometer, and in Gaza about 1,570.[1–4] Approximately 12 percent of the West Bank population, and 53 percent of the Gaza population, live in refugee camps.[2]

Both the West Bank and Gaza are developing areas. In 1987, per capita gross national product was $2,090 in the West Bank and $1,486 in Gaza (up from $836 and $605, respectively, in 1975). In 1987, the crude birth rate in the West Bank was 41 per 1,000 population, while the Gaza birth rate was 48/1,000. In both areas, about half the population is under age 16.[4] Sanitary conditions have improved steadily over the years but still vary widely, with open sewage drainage remaining a problem in Gaza refugee camps.[4,5]

Persistence of Poliomyelitis

In the early 1970s, the Government Health Services in both areas established an expanded childhood immunization program as a major priority. This included four feedings of oral polio vaccine (OPV) in the first year of life.[4–9] By 1975, 85 percent of infants were receiving polio vaccinations, and by 1977 coverage had exceeded 90 percent.[5,7,8] Despite this, however, there continued to be many cases of paralytic polio throughout the 1970s, with many of these cases occurring in children who had received at least one, and up to four, doses of OPV. In Gaza in 1976, half of the 77 polio cases had been fully immunized with OPV, as had eight of 13 cases in 1977.[5]

In response to this problem, a review of polio policy was undertaken in 1978 by the Government Health Services. Vaccine failure was first thought to be due to a deficient cold chain, but testing indicated that the vaccine used in the field was adequately potent.[5,8–10] Diarrheal diseases were widespread, and it was then felt that these might be interfering with OPV take.[5,7,8] It was decided to modify the immunization program to include a combination of inactivated polio vaccine (IPV) and OPV for both the West bank and Gaza, in addition to emphasizing increased immunization coverage and cold chain integrity.[4–6]

Combined OPV/IPV Policy

Since 1978, IPV has been given in the West Bank in combination with diphtheria-pertussis-tetanus vaccine (DPT) in two doses, at 3-1/2 months and 5 months, in addition to five feedings of OPV, given at 2, 3-1/2, 5, 6-1/2, and 12 months. In Gaza, OPV (type I only) is given at age 1 month, followed by IPV and OPV given together at 2-1/2 and 4 months, and OPV alone at 5-1/2 and 12 months. During 1987–88, adequate supplies of IPV were unavailable, and OPV only was used.

Immunization has reached 95 percent of the infant population in both areas, as indicated by immunization data and by serosurveys.[4,8–11] Vaccinations are given through clinics, village health rooms, and mobile services by the Government Health Services, and through United Nations Relief and Works Agency (UNRWA) clinics, which provide primary health care to residents of refugee camps in both areas. UNRWA has followed the combined immunization policy in Gaza; in the West Bank, where UNRWA provides care for only 12 percent of the total population, UNRWA gives OPV alone.

Cases and suspected cases of paralytic polio are hospitalized and reported to public health officials. There is a high

Address reprint requests to Theodore Tulchinsky, MD, MPH, Director, Personal and Community Preventive Health Services, Israel Ministry of Health, 2 Ben Tabai Street, Jerusalem, Israel 91010. Dr. Abed is Director, Gaza Health Services Research Center; Dr. Shaheen is Director, Public Health Department, Government Health Services, Ramallah; Dr. Toubassi is Director, Ramallah Health Services Research Center; Dr. Sever is Chief Medical Officer, Government Health Services, Judaea and Samaria; Mr. Schoenbaum is Public Health Intern, Israel Ministry of Health; Ms. Handsher is Chief, Polio Section, Central Virus Laboratory, Israel Ministry of Health, Tel Hashomer. This paper, submitted to the Journal February 2, 1989, was revised and accepted for publication July 3, 1989.

level of awareness of polio in the medical and general community, and cases are likely to be reported.[4–6] All suspected cases are investigated clinically and with serial laboratory tests carried out at the Central Virus Laboratory of the Israel Ministry of Health. This includes serum antibody levels and stool cultures. Confirmation of cases is based on clinical data, stool cultures, and demonstration of antibody levels increasing over time.[5]

Polio Control

Figure 1 shows annual incidence rates over the 1968–88 period. Both the West Bank and Gaza experienced a decline in polio cases and incidence rates since 1980. During the period 1968–77, Gaza averaged 41.5 cases per year (incidence rate of 10.6 cases/100,000 population). A dramatic decline in polio incidence began in 1978: average cases per year dropped to 7.4 and 0.6 in the subsequent five-year periods (incidence rates of 1.6 and 0.1/100,000, respectively), with one case in 1988. In the West Bank, polio cases averaged some 20 cases per year (3.2/100,000) in the period 1968–77, and began to decline in 1980. There were an average of eight cases per year between 1978–82 (1.1/100,000) and then two cases per year in the 1978–82 period (0.3/100,000), with two cases in 1988.

During 1968–82, Israel averaged 13 cases of polio per year (average annual incidence rate of 0.4 cases/100,000 population). This fell to an average of 1.6 cases per year between 1983–87 (0.04/100,000), but there were 15 cases in 1988 (Table 1).

Table 2 shows a summary of various serosurveys for polio antibody levels carried out in the West Bank and Gaza.[6,8–9,12–14] While the serosurveys did not group children by vaccination status, high levels of immunity in the latter years are due primarily to increased vaccination coverage and improved seroconversion rather than to circulation of wild polio virus, since the incidence of polio decreased during this time.

The 1988 Israel Polio Outbreak

Since 1963, Israel's national routine immunization policy for polio has been to vaccinate infants with four feedings of OPV only. The continued occurrence of endemic polio during the late 1970s, mainly concentrated in five of 15 subdistricts, led to the institution since 1978 of annual spring booster campaigns using type I OPV among all children ages three years and younger in selected areas of these subdistricts.[12,13] Total reported coverage of polio immunization in Israel is over 90 percent.[12–14]

In two other subdistricts in Israel (with 6.7 percent of the total population in 1986), a trial program of three doses of IPV only was carried out between 1982–88.[6,12–14] In 1988, an outbreak of 15 cases of type I poliovirus occurred in Israel; 12 of these cases were from one of the subdistricts (Hadera) using IPV alone. These were largely concentrated in areas of this subdistrict that had serious sanitation problems. The other three cases were temporally and virologically associated with the outbreak, but there was no confirmed physical contact with Hadera. Nine of the 15 cases were 15 years of age or older; nine had received at least three doses of OPV in the past. This outbreak has been described in detail.*[15–17]

The West Bank and Gaza are not immediately adjacent to each other. However, the distances between the most populated areas of the West Bank, Gaza, and Israel average under 50 kilometers. There is very extensive contact between the populations of all three areas (Figure 2).

Despite this, the population of the West Bank and Gaza was unaffected in the 1988 Israel outbreak, although one of the two polio cases in the West Bank may have been epidemiologically connected to the Israeli outbreak. The other case was vaccine associated.** The one case in Gaza in 1988 was epidemiologically unconnected. However, in view of the risk of spread of the disease from Israel to the West Bank and Gaza, a program of administering a booster dose of trivalent OPV to everyone aged 0–40 was carried out, in conjunction with a similar campaign in Israel. This program reached approximately 90 percent of the target population in the West Bank and Gaza.***

The OPV/IPV Debate

The debate on polio policy has been primarily between the Sabin[18] and Salk[19,20] schools who advocate, respectively, OPV-only and IPV-only vaccination policies. The 10-year experience of the West Bank and Gaza reported here suggests that a combined IPV/OPV program can result in polio control even in developing areas with significant sanitation problems and with high potential for the import of wild virus from neighboring areas where wild polio virus is still prevalent.[21]

Oral polio vaccine (OPV) is relatively inexpensive and easy to administer. It induces both humoral and intestinal immunity (secretory antibody response). Due to its oral administration and consequent presence in the intestinal system, it diffuses immunity directly through contact with the vaccinee, and indirectly through the environment, especially in areas with relatively unsanitary conditions.[18,22–29] OPV-induced immunity among contacts of the vaccinee and through the environment is a major advantage over using IPV alone.[25,27]

FIGURE 1: POLIO INCIDENCE RATES
GAZA, WEST BANK, ISRAEL: 1968–1988

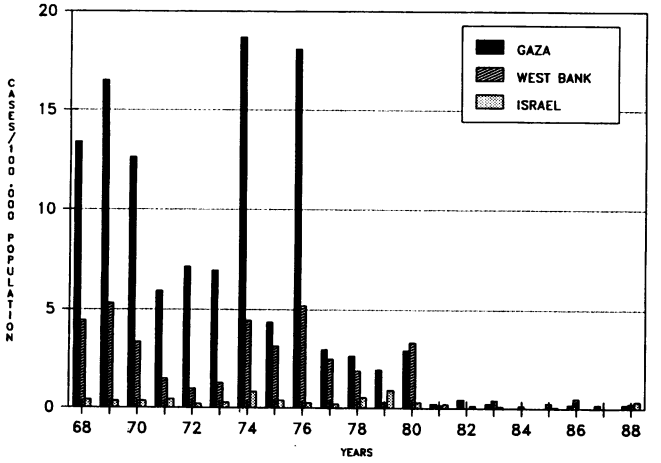

FIGURE 1—Polio Incidence Rates, Gaza, West Bank, Israel: 1968–1988

*Melnick JL, Orenstein WA, Rey M: Report of a consultation on poliomyelitis control in Israel, October 5–6, 1988. Jerusalem: Ministry of Health, 1988 (unpublished); and Slater PE, personal communication, 1989.

**Handsher R: personal communication.

***Tulchinsky TH: personal communication.

TABLE 1—Confirmed Poliomyelitis by Five-Year Periods: Cases, Average Annual Cases, and Annual Average Incidence Rates, West Bank, Gaza, and Israel, 1968–88

	1968–72	1973–77	1978–82	1983–87	1988
Gaza					
Cases	205	210	37	3	1
Average annual cases	41.0	42.0	7.4	0.6	—
Average annual incidence rate	11.1	10.2	1.6	0.1	0.2
West Bank					
Cases	92	110	40	10	2
Average annual cases	18.4	22.0	8.0	2.0	—
Average annual incidence rate	3.1	3.3	1.1	0.3	0.2
Israel					
Cases	53	67	77	8	15
Average annual cases	10.6	13.4	15.4	1.6	—
Average annual incidence rate	0.3	0.4	0.4	0.04	0.34

NOTE: Incidence rates are cases per 100,000 population.

TABLE 2—Serosurveys for Percent with Protective Antibody Levels by Polio Type, West Bank and Gaza

Area/Age Group	Year	No.	Type I	Type II	Type III
Gaza					
6–36 months	1974	50	56%	74%	66%
	1978	50	60	82	70
	1980	117	100	98	100
	1983	209	89	83	82
West Bank					
6–8 years	1983	240	92	96	97
7 years	1986	266	97	99	96

NOTES: Serosurveys were performed with 1:4 dilutions (1974 in Gaza used 1:10). Survey samples were random (1980 in Gaza was follow-up survey of vaccinees only).

However, successful immunization with OPV requires four doses at appropriate intervals. In addition, because OPV contains an attenuated live virus, there are rare cases (1 per 2.6 million doses in the United States for 1974–84) of vaccine associated disease, in which the vaccinee or a person in contact with the vaccinee incurs paralytic polio from mutated vaccine virus.[22,25,27,30–31] Additionally, there is strong evidence that OPV take is inhibited if the vaccinee is infected with other enteroviruses, resulting in failure of the vaccine to produce satisfactory levels of protective antibodies.[23,24,26,31]

Inactivated polio vaccine (IPV) rapidly produces a high level of protective antibodies. It poses no risk of vaccine-associated disease, and is not susceptible to interference from other enteroviruses.[26] IPV also protects vaccinees (although not necessarily their contacts) from vaccine-associated disease contracted from OPV doses administered subsequently.[25–27] Newly developed enhanced-potency IPV vaccines are even more effective in terms of speed and level of immunogenicity than previous inactivated vaccines.[22,24]

However, IPV produces only limited intestinal immunity. This permits vaccinees who receive only IPV to be acute carriers of polio. The wild polio virus can enter and infect the intestinal tract of vaccinees, who will not themselves contract paralytic polio, but may excrete the virus, spreading it through the environment or directly to other people.*[25–27]

The Combined OPV/IPV Approach

Both vaccine types have proven effective in controlling

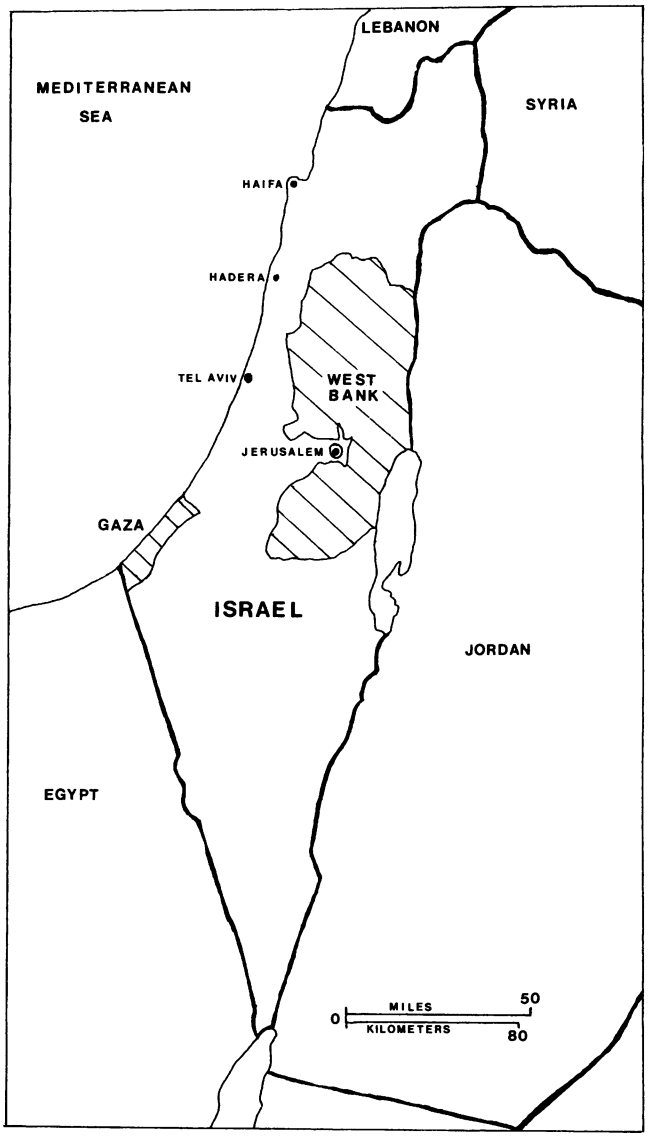

FIGURE 2—Map of Israel Showing West Bank, Gaza and Hadera (site of 1988 outbreak)

*Melnick JL, Orenstein WA, Rey M: Op Cit.

polio in developed and developing countries. However, particularly in less than ideal sanitary conditions, neither type used alone seems capable of eradicating the disease. Recently, the combination policy of IPV and OPV administered sequentially has attracted interest internationally.[22,26–27,32–33] Denmark has been using such a policy successfully since 1968.[27,32]

Although poliomyelitis is an acute viral disease affecting humans only, with no animal host and no chronic carrier status, it can be imported by infected persons from outside a given geographical area. Polio virus can then be transmitted by contact or through sewage and waste processing systems.

Developing countries often face great difficulties in vaccinating the numbers of people necessary for adequate herd immunity. In addition, they face problems of interference with vaccine take from other enteroviruses. The policy of combining OPV and IPV is well suited for minimizing the effects of these problems.

As the 1988 polio outbreak in Israel illustrates, an IPV-only vaccination policy for areas with sanitary problems, and where wild polio virus is present, has potential for failure. The 1985 polio outbreak in Finland, even though associated with an inadequately immunogenic IPV (for type 3), further suggests that an IPV-only policy may not produce adequate levels of herd immunity even in areas without serious sanitary problems and where wild polio virus introduction may be unlikely.[21,28] In Holland, where IPV has been used alone, repeated introductions of wild polio virus were associated with relatively large numbers of cases (114 over the period 1974–84), mostly among non-immunized members of religious communities. Introduction of wild polio virus to an area by travelers to and from developing areas is a risk factor that must be considered when determining polio vaccine policy.[25]

The spread of immunity through personal and environmental contact from OPV use is a major advantage; the reduction or elimination of vaccine-associated polio by use of IPV is also a major advantage. The West Bank and Gaza experience show the effectiveness of combining IPV with OPV in areas where OPV alone has a high failure rate.

The combined policy has the further advantage of at least partially mitigating the problem of incomplete vaccination schedules. Giving OPV and IPV at the same time makes it likely that infants, particularly in populations where return visits for further vaccinations cannot be guaranteed, will be protected even after only three visits although a complete schedule is more desirable. The new, high potency IPV's ability to rapidly create high levels of protective antibodies makes seroconversion more likely, even with incomplete vaccination schedules. In the applied field setting, the combined policy can lend itself both to routine campaigns and to the blitz campaign approach used in some developing countries.[24,31,34]

In addition, the combined IPV/OPV policy can reduce or eliminate the risk of vaccine-associated polio, which remains an important factor in the epidemiology of the disease. As an example, four of the eight Israeli polio cases occurring between 1982 and 1987 were vaccine-associated, even though the rate of vaccine-associated polio reported in the United States is considerably lower. For this reason, IPV should be given before or with the first OPV dose, since the greatest danger of vaccine-associated disease comes from the first dose of OPV in individuals previously unvaccinated against polio.[29]

International Implications

The global eradication of smallpox was an outstanding achievement, with enormous benefit to the world. It was achieved by a combination of a safe, effective vaccine, new technology in vaccination, a world consensus on the need to act, and excellent strategies in application of the technologies available.[23] As the World Health Organization (WHO) now has targeted polio for eradication, it is vital to develop the most appropriate strategies in the use of existing and new technologies. Polio eradication will be more complex than was smallpox eradication because of differences in transmission, clinical manifestation, interference, and duration of immunity. Perhaps most importantly, immunity to polio requires multiple doses and boosters, whereas a single dose of smallpox vaccine confers lifelong immunity.[23]

As a result of the importance and complexity of the issue, documented field trials of various approaches to polio control are needed. The West Bank and Gaza experience in use of the combined OPV-IPV approach should be considered for replication in wider field trials in the search for appropriate strategies in polio control/eradication, particularly for developing countries. The Israel Ministry of Health has recently decided to adopt the combined OPV/IPV approach for its future immunization policy. Although the combined approach is more expensive than OPV alone, its advantages make the combined approach an essential tool in the world battle to eradicate polio.

ACKNOWLEDGMENTS

We wish to acknowledge the important contribution to this work by Prof. Joseph Melnick of Baylor Medical School, Houston, Texas; Prof. Natan Goldblum, Virology Department, Hebrew University Faculty of Medicine; Prof. C.H. Gerichter, former Director of Public Health Laboratories, Israel Ministry of Health; Dr. Eli Lasch, former Chief Medical Officer, Gaza; Mrs. Zilla Acker and Mr. Micha Blum, Government Health Services, Judaea and Samaria (West Bank); Dr. Samir Badry, Medical Director, UNRWA, Gaza; as well as the Palestinian staff of the UNRWA and Government Health Services in the West Bank and Gaza. We also wish to thank Dr. P.E. Slater and Dr. C. Costin, Epidemiology Department, Israel Ministry of Health, for their assistance. The 1986 serosurvey on the West Bank was in part sponsored by the World Health Organization.

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Business and Nursing Schools Join Ranks to Develop MBA-MSN Degree Programs

Ten of the nation's top-rated graduate schools of business are joining ranks with their graduate schools of nursing to provide future nursing leaders with the same caliber of management, financial, and analytic training usually reserved for the business world. Superior management skills—combined with their clinical skills—are essential to tomorrow's nurse leaders. This unprecedented alliance between the schools of business and nursing "to develop joint MBA-MSN degree programs comes in recognition of the enormous resource allocation, quality control, and employment practice decisions now made by nursing leaders," said Dean Meyer Feldbert of Columbia University Graduate School of Business.

Nursing comprises the largest workforce in the health care industry, and health care is the nation's third largest industry, with expenses approaching $2 billion per day.

Almost 300 nurses with MBA degrees were recently surveyed for The Commonwealth Fund by Louis Harris and Associates, which found that most nurse-MBAs get far more managerial responsibilities as a result of their MBA degree. The most valued skills, according to the nurse-MBAs surveyed, were in finance and marketing. Eighty-eight percent of respondents advised other nurses like themselves to get an MBA degree.

Each of the universities developing the new joint degree programs will receive $100,000 in start-up support from The Commonwealth Fund. The Fund will also provide fellowships of $15,000 each to 25 nurses per year, as further encouragement of this type of education.

The 10 universities developing MBA-MSN graduate degree programs are: University of California (Los Angeles), Case Western Reserve University (Cleveland), Columbia University (New York City), Iowa University (Iowa City), University of Michigan (Ann Arbor), University of Rochester (New York State), Rush University/Northwestern University (Chicago), University of Texas (Austin), Vanderbilt University (Nashville), and University of Virginia (Charlottesville). Courses are due to start in Fall 1990.

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