Child survival—world survival
An epidemiologist’s story

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RALPH H. HENDERSON, MD, Director, Expanded Programme on Immunization
World Health Organization, Geneva, Switzerland

I speak for an army of health workers who are bringing immunisation services to the children of the world and, in doing so, are building health care delivery systems capable of stopping the spirals of infection—malnutrition which sweep so many children in developing countries to their death.

Some of us who are engaged in these efforts are, like myself, international health workers. We belong to the World Health Organization, to UNICEF and to other United Nations agencies. We belong to official development agencies, such as the Overseas Development Administration here in the UK and similar organisations representing most of the world’s industrialised countries. We also belong to private, voluntary and religious organisations such as the International Children’s Center, Médecins sans Frontières, Rotary International, the Save the Children Fund, World Vision International, and a host of others.

We international workers tend to get (and sometimes actively seek) publicity and praise, but the real heroes and heroines are found among the hundreds of thousands of health personnel working at national and local level in the developing world. Those at the periphery are the most poorly trained and the most poorly paid, yet they are the ones who, day in and day out, bring immunisation services to mothers and children. To do so, they battle the frustrations of lack of fuel, of power failures, of breakdowns of equipment and transport and of chronic shortages of vaccines, syringes, needles and sterilisation materials. They are making this effort the success that it is, and I dedicate this lecture to them.

Beginnings

The Smallpox Eradication Programme, initiated by WHO in 1959, provided the conceptual foundation for the Expanded Programme on Immunization (EPI). If smallpox had not been eradicated [1] in 1980 we might not have had the courage to dream the dream of achieving universal child immunisation by the end of this present decade, and the World Health Assembly would certainly not have dared to commit WHO to the global eradication of poliomyelitis by the year 2000, as it did in May 1988.

Picture the scene in Nigeria in 1966: rude huts hastily constructed as an isolation camp for smallpox cases. Here were the beginnings of a renewed smallpox eradication effort after 7 years of little progress. Vaccine had run short in the midst of an epidemic. A strategy of necessity was born: stop mass immunisation and concentrate instead on identifying and immunising those, generally few in number, who had actually had contact with an infective case.

This strategy was initiated by Dr William Foege, a young epidemiologist serving in Eastern Nigeria with the USAID supported smallpox–measles programme. The idea clashed with conventional wisdom and with conventional practice of the day. Yet programme leaders had the courage to consider it, and the idea took root as it was tested with success in area after area. By the early 1970s, under the name of ‘surveillance and containment’, it had become the main strategy of the global eradication programme.

Lessons applied

Our surveillance and containment experience naturally led the EPI to direct immunisation strategies to reaching those at highest risk from the target diseases, but we broke sharply with practice when we insisted that first priority should be given to immunising children in the first year of life, and as early in that period as we could manage. It used to be the practice in many Third World immunisation programmes to concentrate their efforts on children who were actually in school. However, because most of the children had already suffered from one or more of these diseases against which immunisation was being provided, the impact of these programmes was negligible. The error was compounded by the fact that many children were omitted because they did not attend school, and by the fact that the vaccines were often ineffectual at the time of administration because they had not been kept at the correct temperature.

The smallpox programme taught the EPI other lessons as well. Much of the donated equipment had
been selected by well-meaning individuals in industrialised countries, where it was manufactured and designed for use in temperate climates, to run on clean fuel or on continuous supplies of electricity at constant voltages. None of these conditions tends to apply in developing countries. For example, in Mali, American-made trucks carried jerry cans with spare petrol next to an open-flame powered butane refrigerator. Not surprisingly, a number of trucks exploded, happily without loss of life. Moreover, the refrigerators had not been designed to operate in the temperatures typical in Mali, which frequently reach 40°C. In that heat, the refrigerators could not maintain internal temperatures necessary for keeping measles vaccine without loss of activity.

The experience with unsatisfactory equipment led us to constitute a special unit concerned with what we call the ‘cold chain’: the system of people and materials needed to ensure that potent vaccines are available to health workers as needed. In the late 1970s this unit began developing standards for materials used in EPI, and UNICEF agreed to supply only materials meeting these standards, as tested in independent laboratories. UNICEF partnership was critical, as their purchasing power provided manufacturers for the first time with effective incentives to improve their products. The process of independent testing has proved to be invaluable, as the testing laboratories have frequently been able to offer practical suggestions to manufacturers on how to improve their products.

As a result, a whole new generation of refrigerators, freezers, cold boxes and other materials has been produced so that, at present, reliable equipment is available to serve the needs of most of the developing countries. Outbreaks of disease among those who had been vaccinated have dropped from a frequent to a rare occurrence. In fact, we are now becoming more confident of the health of the ‘cold chain’ in many developing countries than in industrialised countries, where vaccine handling practices are often quite lax.

We also learned lessons relating to monitoring and evaluation. During the smallpox days, we had developed a simplified cluster sampling technique which permitted us to estimate immunisation coverage accurately to within about 10% of the true population mean. We used random selection to identify 30 different starting points within our geographic area of interest. At each point, 7 persons were surveyed in each age group of interest, starting with an initial household and then surveying the households nearest to it until the sample had been completed [2]. With the development of the EPI, we made it a standard method for checking immunisation coverage [3]. By the end of 1988, some 2,600 such surveys had been conducted in national programmes and reported to WHO. They have been an enormous help in providing objective data on immunisation coverage which can be used as a way of validating and improving routine information.

As we have worked with developing countries to build up their immunisation services, we have become increasingly aware of two problems whose solutions hold the key to success. They are problems of ‘drop-outs’ and ‘missed opportunities’.

Drop-outs are children who start with the first dose of vaccine but fail to complete the immunisation series. The problem is easy to understand. Mothers in developing countries are overburdened with work, and time is precious. For a mother, a clinic visit is a major investment; she will not return unless she has a good reason. She certainly will not return:

- if she has had to wait a long time,
- if she has come and the clinic has run out of vaccine,
- if the staff are condescending or impolite, or
- if she has not been warned that the immunisation may make the child fretful and that she must complete the immunisation series to have full protection.

Even if the staff have done everything right, things may still go wrong. Vaccine failures do occur, as do adverse reactions. More frequent, however, are chance associations between immunisations and illness or death, which are common in developing areas. It is hard to convince parents that immunisation has not caused such problems.

Missed opportunities may arise in immunisation centres because they frequently adopt policies used in industrialised countries. For example, DPT and polio immunisations may be started only at the age of 3 months and immunisation deferred unless the child appears perfectly healthy. Horror may be expressed when one suggests giving all the vaccines in a single visit. But these policies are not appropriate in developing countries where health services are scarce and the EPI target diseases strike early and with devastating effect. Each visit should be used to provide as many services as possible, consistent with safe medical practice. Immunisation should begin at the first opportunity. The first contact after birth can be used to give BCG and, in countries where poliomyelitis remains endemic, a dose of oral polio vaccine. DPT should be started from the age of 6 weeks, giving three doses spaced at 4-week intervals. Oral polio vaccine should be given at the same time. In countries where measles in the first year of life is a problem, measles vaccine should be given as soon as possible after the age of 9 months. If we see a child aged 9 months which has not yet had any immunisation, we recommend that BCG, DPT, polio and measles vaccines be given at the same visit. The administration of these vaccines in one visit is both safe and effective [4].

Many parents in developing countries seek health care only when their child is ill, and the ill or malnourished child is especially at risk of dying after acquiring pertussis or measles. In such circumstances, unless there is a specific contraindication such as a severe reaction to a previous dose of DPT vaccine, if the child is well enough to be sent home the child is well enough to be immunised. There is a special urgency to immunise ill or malnourished children. This recom-
Mendation is given increased importance by the risk of acquiring a vaccine-preventable disease during a clinic visit. During the measles epidemic season, for example, many children are brought to a health worker because the child is ill with measles. Unimmunised children who are in the clinic at the same time are thus at risk from acquiring measles. The extent of this risk has been difficult to evaluate in the outpatient setting, but measles acquired in hospital is so frequent in some areas that we recommend measles immunisation immediately on admission, even if the child is seriously ill, beginning at the age of 6 months, with re-immunisation as soon as possible after the age of 9 months [4].

Missed opportunities may also arise in clinics that provide curative services but not immunisation. If eligible children with minor illness should be immunised, there is every reason to provide immunisation in clinics seeing sick children. We recommend that immunisation be integrated with other health services which are relevant for both mothers and children, and that a visit for any reason be fully exploited to provide all the services that are appropriate [5].

We feel that the missed opportunity problem is widespread and significant. We have been trying to alert national authorities to this issue through a series of studies. These often show that, when leaving a treatment centre, 60–70% of the children eligible to receive immunisation have not been immunised [6–10].

These problems are difficult, but by no means impossible, to solve. As the EPI has gained increasing acceptance, more countries are reviewing their immunisation schedules to make them simple, effective, epidemiologically appropriate and socially acceptable. The WHO policy on contraindications to immunisation received the endorsement of the International Pediatric Association in 1984, and our recommendations have also been adapted for consideration within the European region [11]. Having been alerted to the problem of missed opportunities by a WHO study, the authorities in Zimbabwe instituted a practice in the paediatric clinics in Harare in which each ill child is screened by a nurse for immunisation status and the necessary immunisations are carried out even before the child is seen by the physician. A follow-up study was unable to identify even one child who had failed to receive the immunisations for which it was eligible [12].

**Results**

We are very proud of what has been accomplished by the EPI. Immunisation services which were virtually non-existent in developing countries in 1974 now administer measles vaccine to half the children of the world (generally by early in their second year of life). They administer a third dose of polio or DPT vaccine to 60% of children reaching their first birthday, and BCG vaccine to more than 65%. Almost 2 million deaths from measles, pertussis and neonatal tetanus, and almost a quarter of a million cases of poliomyelitis, are now being prevented each year by immunisation services in developing countries [13].

Of course our job is far from being finished. Many children still remain unprotected. Each year almost 3 million children still die, over 200,000 are paralysed and some 150,000 are blinded from these diseases. We have every intention to raise immunisation levels in all countries to at least 80% by the end of 1990.

**International help**

Success for the EPI depends primarily on the health workers in developing countries, but international support is also important. WHO has given technical leadership in providing training materials and in helping national managers to develop monitoring and evaluation systems, through which it is now possible to measure programme progress. Our major international partner in this work is UNICEF. It is the main supplier of vaccines and ‘cold chain’ equipment to developing countries. It has also been extremely active and effective in mobilising social opinion in favour of immunisation. The yearly UNICEF publication *The state of the world’s children* has brought to the attention of world leaders the problems afflicting children in developing countries, and the impact that low-cost interventions (including immunisation, oral rehydration for the treatment of diarrhoea, breast feeding, growth monitoring, food supplementation, family planning and female education) can have in promoting child survival and development. Our long-term goal is to change social value systems so that a single case of a vaccine-preventable disease will be regarded with all the dismay that a case of smallpox would elicit today.

Among our other EPI partners, we count United Nations agencies such as the World Bank and the United Nations Development Programme (UNDP), the Rockefeller Foundation and most of the major bilateral development agencies.

Some of the most innovative and effective support has come from non-governmental organisations. The Save the Children Fund of the United Kingdom under its ‘Stop Polio’ campaign has been of substantial help to both WHO and UNICEF in supporting immunisation efforts, especially in Africa. Similar funds in the Netherlands and the United States are also providing support at country level.

Perhaps the most dramatic non-governmental initiative has come from Rotary International, under their ‘PolioPlus’ initiative. Rotary asked their member clubs to raise US$120 million, to be used mainly for the purchase of polio vaccine for developing countries. Rotarians responded with pledges of over US$200 million. Even more important than the funds, however, is the impact that thousands of individual Rotarians are having through their personal commitment to the immunisation cause, lobbying in industrialised countries for more resources to be donated for immunisation, and working in developing countries to raise the rank of immunisation on the social agenda.
Programme costs

Our data are not very exact, and they vary considerably from country to country. Overall, however, we estimate that it costs approximately US$10 fully to immunise a child. Developing countries generally pay 70–80% from their own budgets, largely representing the salaries of staff and operating costs. Outside contributors provide the rest, and this generally consists of vaccines and the supplies and equipment needed to transport, store and administer them.

Our goal for 1990 is fully to immunise each year some 100 million children in developing countries. The global cost of the programme thus comes to around $1 billion a year, with the industrialised countries annually contributing 200–300 million dollars. These are large sums in one sense, but small when one considers that the estimated annual global military expenditure today is on the order of a trillion dollars, or a thousand times the cost for the EPI.

Toward the year 2000

Challenges include sustaining high levels of immunisation coverage, and focusing the efforts of our programme on controlling, eliminating or eradicating the target diseases themselves. Special emphasis is being placed on the control of measles, the elimination of neonatal tetanus and the eradication of poliomyelitis. ‘Control’ signifies a marked reduction in cases of the disease. ‘Elimination’ signifies that no cases occur, although the organism causing the disease remains a threat. ‘Eradication’ signifies no cases and the disappearance of the organism(s) responsible for the disease.

Measles

Measles is the most lethal of the EPI target diseases. We estimate that some 51 million cases and 1.6 million deaths now occur each year in developing countries in addition to 150,000 cases of measles-related blindness. Causes for high case-fatality rates seem to relate both to underlying malnutrition and intensity of exposure to disease [14]. Recent studies have also underlined the fact that children who survive an acute attack of measles continue to have higher mortality rates than their peers for some months afterwards, deaths being attributed to a variety of other causes [15–17]. The virus is highly contagious. Although eradication targets have been set in a number of industrialised countries, most have not yet attained them. During the coming decade, global efforts will be directed towards measles control, leaving eradication as a hope for the years following the turn of the century.

The exciting prospect now exists of having measles vaccines that are able to resist the interference of maternal antibodies to an extent that may permit the recommended age of immunisation to be lowered from 9 months to 6 months or even earlier [18]. Measles before the age of 9 months has emerged as a major problem in developing countries, particularly in urban areas. Transmission is so intense in these areas that it is not being interrupted by the immunisation of older children, as we had hoped it might at the beginning of the programme.

Neonatal tetanus

Neonatal tetanus currently causes some 750,000 deaths each year. Not one should occur. All that is required is to prevent tetanus spores from coming into contact with the healing umbilical cord. Tetanus spores are found in soil, especially in the vicinity of cattle. Elementary hygiene at the time of childbirth and ensuring that the umbilical cord remains clean until it has healed will prevent all cases.

Ensuring that the mother has had a full course of tetanus immunisation before delivery will also prevent all cases, as the mother’s antibodies cross the placenta to provide the newborn protection for the first weeks of life. This will also prevent maternal tetanus, an unfortunately common complication of delivery in developing countries.

Because the tetanus organism does not require man as a host to survive, it will always remain in the environment. The EPI goal is therefore tetanus elimination rather than eradication. This will pose special challenges, since the women who need to be reached with tetanus toxoid and with safe delivery practices and post-delivery care tend to be those who are systematically missed by the health services. This may be because they live in remote areas where health services are not accessible, or because they belong to population groups that actively shun the use of such services.

Poliomyelitis

Poliomyelitis has virtually disappeared from most industrialised countries in the approximately 30 years since polio vaccines have been available. A number of countries have been successful in eliminating the endemic transmission of wild polio viruses for periods of several years, suggesting that the goal of global eradication of this disease is feasible. But we already know from the American hemisphere, where they are well on their way to eradication of the polio virus by the end of 1990, that large urban areas are likely to pose a particularly difficult challenge, contributed to by high population densities which favour viral transmission and by high immigration rates and social disorganisation which characterise so many urban fringe areas.

We have developed a plan of action for the global eradication of poliomyelitis which we estimate will cost some US$155 million in external support to achieve, over and above the costs for sustaining routine immunisation programmes. For reference, the total cost of smallpox eradication was estimated to be US$300 million. Put in other terms, the costs of smallpox eradication and the estimated costs of polio eradication are each of the same order of magnitude as the amounts already needed each year from outside donors to support the ongoing EPI.
Our other major concerns for the coming decade are the introduction, as quickly as possible, of new vaccines that are appropriate for wide public health application, support of other simple and cost-effective health interventions that are compatible with the EPI delivery systems and target populations, and support of research and development relevant to all aspects of the programme.

Child survival — world survival

With much hard work and a bit of good fortune, not only will we have eradicated poliomyelitis by the year 2000, we will also, on the way, have prevented on the order of a billion cases of measles and eliminated neonatal tetanus. However, our world is already bursting at the seams with people, with population growth rates highest in the countries that can least afford them. In these circumstances, is the immunisation programme really such a good thing?

We can reflect for just a minute on an alternative approach, that of doing nothing so as to let disease and malnutrition take their toll, but this is hardly conceivable on ethical grounds. Perhaps fortunately, we need not agonise over the matter since this approach simply does not work in the circumstances currently prevailing in developing countries. Countries with the highest infant mortality rates are already those that have the highest birth and population growth rates.

Family planning

So, should family planning be pushed more aggressively? No and yes. If half the children in a family can be expected to die before the age of 5 years, a common statistic in poorer countries, and children are considered bread-winners and social security for their parents, why limit them to one or two? Rich countries that try to impose only family planning on poor countries do not enjoy a very warm political reception. On the other hand, family planning services could be offered as part of a comprehensive package of programmes to improve health and promote development. Reducing infant and under-5 mortality rates appears to be one of the most effective ways of reducing birth rates.

Child spacing

Here the emphasis is not primarily on population control but on the health of the mother and the child. The child born within 2 years of an older sibling is twice as likely to die in the first year of its life and 50% more likely to die between the ages of 1 and 5 years than the child born after a longer interval. Mothers also need this interval to replenish their main energy stores. If mothers are empowered with the knowledge and the resources to space their children, they can also limit their families according to their desires. At present, many women in developing countries have more children than they want.

Child spacing and immunisation are therefore syner-

gistic. Each contributes to lowering infant under-5 mortality. As more children remain alive, parents have more reasons to limit their families. The same applies to other measures that promote child survival, many of which we also actively promote through the EPI. All these interventions go hand-in-hand.

Education

Education of the mother is one of the best general ways of reducing child mortality. There are many simple things she can do, even with scarce resources. For example, she can avoid commercial appeals to stop breast feeding. She can start weaning appropriately and ensure that the infant not only gets its fair share of the family food but that the share has sufficient calories and vitamins. She can force fluids and feed the child with diarrhoea, which mainly kills through simple dehydration. She can also seek immunisation and other preventive and curative health services when they are needed.

But we are entering dangerous ground. The education of women lags far behind that of men in most developing countries, and many men find this to their liking. Women are restrained from making policies within the household, including using family planning methods and influencing the distribution and nature of the food that is consumed. Yet educated women, like educated men, are a powerful resource. In taking an equal place in society, they share work at all levels, contributing to development. This adds more incentives for limiting the numbers of children.

World survival

At present we invest in the future of our planet mainly by buying arms. We are not to any significant degree investing in the development of poorer nations. President Eisenhower put the case eloquently when speaking to the American Society of Newspaper Editors in 1953: ‘Every gun that is fired, every war ship launched, every rocket fired signifies in the final sense a theft from those who are hungry and not fed, those who are cold and not clothed. This world in arms is not spending money alone, it is spending the sweat of its laborers, the genius of its scientists, the hopes of its children’.

In its 1989 State of the World’s Children report [19], UNICEF has described the current climate regarding the provision of development aid: ‘In the industrialised countries, public disillusionment with aid and development is in large part a result of using aid as an instrument of political advantage, or military strategy, or industrial subsidy. In the case of the United States, for example, over 30% of non-military aid goes to just two countries—Egypt and Israel. Not one country in Sub-Saharan Africa, the world’s neediest region, or India with almost half of the world’s absolute poor, is even in the top ten recipients of American aid. In the case of the United Kingdom, where aid as a percentage of GNP has also declined in recent years, 75%
of official bilateral aid is tied to the purchase of British goods and services. Aid from the Eastern bloc is usually even more firmly tied to the exports of the donor nations.'

A certain amount of investment in national defence is necessary, and investments that favour short-term self-interest are understandable. But growing gaps between the 'haves' and the 'have nots' in our world must also be addressed, for they represent the most serious threat to our survival. Imagine a tomorrow if developing countries do not develop, burying the industrialised world in a sea of humanity living at subsistence level, depleting their own natural resources, adding to global pollution and desperate to share the wealth of the rich. We simply must work for social equality, so that individuals in all societies have a decent chance for food, clothing, housing, education and productive work, and so that political leaders in all countries are given possibilities as well as incentives to halt the mindless destruction of the environment which is now proceeding at such an alarming pace. These are realistic aspirations only so long as population growth remains in control.

The provision of immunisation services, along with a number of other primary health care initiatives, is a beginning point for addressing these broader issues of our own survival. We are chipping away at reducing infant and child mortality. We are chipping away at improving educational levels of women and in introducing family planning. Of course we need to do much more.

UNICEF has estimated the cost of adequate investments in human development, including health services, nutrition, education and housing, at some US$30-50 billion per year. This amounts to less than half of 1% of the world’s $13 trillion economy and some 5% of world military spending [20]. Surely these investments must be afforded.

Already, a remarkable change in the world attitudes is taking place, stimulated by events such as the arrival of acid rain, the Chernobyl nuclear accident, the depletion of tropical rain forests and the concern over the depletion of the earth’s ozone layer and global warming trends. But the progress remains frustratingly slow, each delay making our task that much more difficult.

Listen to the Chilean poet Gabriela Mistral: she is appealing on behalf of the individual child. But this same appeal applies to our planet today:

'We are guilty of many errors and many faults but our worst crime is abandoning the children, neglecting the fountain of life.

Many of the things we need can wait.
The Child cannot.
Right now is the time his bones are being formed,
his blood being made and his senses are being developed.
To him we cannot answer ‘Tomorrow’.
His name is ‘Today’.'

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