Cover:
For ten years the world has been spared such a sight—a baby suffering from smallpox.
Photo WHO

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Ten years have now elapsed since the world’s last case of endemic smallpox was detected, in Somalia. Ten years are surely enough to convince even the most hardened sceptics—and there were many—who said that smallpox was too insidious a disease to be really eradicated from the planet. Surely it would turn up again to plague mankind as it has done since time immemorial?

Nevertheless smallpox has gone from the world. Throughout the past decade, the alarm bells have rung many times. Smallpox has been “definitely diagnosed” in this country or that. But WHO’s meticulously kept “international rumour register” proves the value of unremitting surveillance: every alarm has turned out on investigation to be a false one—the result of chickenpox or measles or skin disease or erroneous press reporting.

The eradication of smallpox is a truly sensational example of what can be done when all the nations of the world pull together in a venture that will benefit not only our generation but that of our children and our children’s children. When the history of the twentieth century comes to be written from the standpoint of the twenty-first, this achievement will undoubtedly rank alongside such wonders as the mastery of flight and the landing of men upon the moon.

We at WHO are proud of the part we played in this achievement—but we are not resting on our laurels either. The next step is to harness the same international will and energy to bring about the whole package of educational, environmental, social, behavioural, medical, organizational and managerial actions that we call Health for all by the year 2000. And in so doing, we shall make good use of the lessons we learnt in those stirring years when the pock-marked map of the globe was gradually cleansed until the last vestige of smallpox was wiped away for ever.
In October 1977, health staff working in the small port of Merka, in southern Somalia, diagnosed a case of smallpox in a 23-year-old hospital cook named Ali Maow Maalin. He was isolated, and his friends and co-workers who had been in close contact with him were located, examined and vaccinated. Health teams then fanned out in search of every case of chickenpox and skin rash they could find. No more smallpox was discovered.

Mankind had seen its last case of this endemic disease. Smallpox "target zero" had now indeed been achieved. The ancient scourge, which had killed millions since the dawn of civilization, was finally eradicated. This fact was certified, in a historical session, by the Thirty-third World Health Assembly of the WHO in May 1980.

But the job was not yet finished. It was necessary to convince the world community that the disease had gone forever, to ensure that advantage was rapidly taken of the benefits of this achievement. Despite the overwhelming evidence that the world had been freed from smallpox, measures needed to be taken by the Member States and their Organization to ensure that this situation remained permanent. Recommendations formulated by the Global Commission for the Certification of Smallpox Eradication and the newly-established special WHO Committee on Orthopoxvirus Infections assisted WHO to map out a post-eradication "insurance policy" focusing on the main goal: public safety by maintaining the world permanently free from smallpox.

Vaccination policy: The modern world had built up an elaborate system of defence against smallpox which included compulsory vaccination and constant checks on international travellers. Already part of that system was being dismantled by 1977, when worldwide eradication became imminent. By that time, routine vaccination, which had been in existence for over 175 years, was no longer required in several countries of North America, Europe and the Western Pacific. Even so, 133 countries were still continuing routine vaccination programmes.

With the certification of the eradication of smallpox in May 1980, the representatives of WHO's Member States endorsed the recommendation that routine vaccination against smallpox was no longer justified and should be discontinued in every country. By the end of 1984, all countries had ceased smallpox vaccination of the general public.

Routine vaccination did not cease instantly, as appropriate instructions were not always transmitted throughout the health services. In some places, smallpox vaccine continued to be made available on request. Health staff in these countries had to explain to anxious parents that the risks posed by vaccination for their children stood against "zero" benefits. There was no disease to be feared. Some physicians had to be persuaded that smallpox vaccination has no value in treating or preventing recurrent herpes infections, warts and so forth, and that, furthermore, misuse of smallpox vaccine for such treat-
ment is associated with the risk of severe complications.

In 1983, WHO contacted governments and vaccine producers and urged them not to distribute vaccine to civilians. Nevertheless, military personnel have continued to be vaccinated in some countries, resulting in the accidental vaccinal infection of their civilian contacts. In 1983, in order to prevent such incidents, the Committee on Orthopoxvirus Infections recommended that "military personnel who have been vaccinated be confined to their bases and prevented from contacting unvaccinated persons for a period of two weeks following vaccination". And in 1986 the Committee proposed that smallpox vaccination of military personnel be terminated. Smallpox vaccination is now only required for the small number of laboratory workers who handle variola virus or closely related orthopoxviruses in their laboratories. Vast sums taken from scarce health resources and spent on smallpox vaccination in the past are now diverted to other pressing public health problems.

Checks on international travelers: In May 1980, the Member States agreed to withdraw requirements for valid smallpox vaccination certificates for international travellers, and the following year smallpox was formally struck from the International Health Regulations. Despite health administrations withdrawing such requirements, international travellers and crews of ships and aeroplanes were occasionally asked for such certificates at ports and airports, when applying for visas, or simply by travel agencies who cooperated with national health authorities to clarify reports of such incidents, which had virtually ceased by 1986.

Reserve stock of smallpox vaccine: In order to free the world from vaccination regulations, national health authorities had to be absolutely sure that smallpox was gone and that a smallpox vaccine reserve is kept in case of unexpected emergencies. A reserve stock was established by WHO in 1980, and its existence made it much easier for Member States to decide to discontinue both smallpox vaccination and vaccine production. It has been widely publicised that vaccine from this stock can be made available and, in an emergency, could reach any country in the world within 24 hours.

At the end of last year the stock amounted to more than five million ampoules which, with the use of bifurcated needles, would be sufficient to vaccinate about 250 million persons. Considering that nearly ten years had elapsed since the last endemic case of smallpox and that human monkeypox had not proved to be a significant health problem, the Committee on Orthopoxvirus Infections considered in March 1986 that there was no further need for WHO to maintain the global vaccine reserve.

Reports on smallpox prove false: We had no doubt that reports of suspected cases of smallpox would reach WHO for several years after the declaration of its eradication. The thorough and prompt investigation of such reports, backed up by laboratory examination and subsequent disclosure of results, would be a very important element of post-eradication surveillance. Any report of a suspected case is regarded as a public health emergency and has to be promptly investigated. Since 1980, WHO has coordinated the investigation of 131 rumours of suspected cases, recorded in an International Rumour Register. The key role in confirming a correct or incorrect diagnosis lies with two collaborating centres, at the Centers for Disease Control, Atlanta, USA, and at the Research Institute for Viral Preparations, Moscow, Soviet Union, who provide laboratory diagnostic services. No single case of smallpox has been proven.

Variola virus after eradication: Once the transmission of endemic smallpox had ended, the only known source of variola virus—and a potential danger for the future—resided in laboratories

Facing page: Helicopters helped to close the net on smallpox in Somalia.
Photo WHO/E. Shafla

Right: Health workers summoned people to come forward for vaccination, offered cash rewards for anyone reporting a smallpox case, and stuck up posters to explain the campaign. Eradication meant savings in time and money for everyone at airport health control points.
Photos WHO/P. Almasy; WHO/E. Shafla; WHO/P. Almasy and WHO/Novosti

World Health, Aug./Sept. 1987
holding stocks of variola virus. WHO began trying to reduce their number even before smallpox-free status had been reached.

In 1975, WHO officials contacted all those countries and individual laboratories known to have worked with the virus in the past. By the end of 1976, 75 laboratories were identified which held stocks of variola virus.

The following year, the Thirtieth World Health Assembly recommended that stocks be retained only in WHO Collaborating Centres and under conditions assuring the maximum safety. WHO officials sought to persuade the laboratories to destroy the virus held or transfer it to the WHO Collaborating Centres.

Lost or hidden vials with variola virus remained a worldwide concern at that time. There was no way for WHO officials to go through every deep-freeze in the world and look at each vial. Only 18 laboratories were known to have retained variola virus at the end of 1977. The laboratory-associated outbreak of smallpox in Birmingham, United Kingdom, in 1978 and the declaration of the eradication of smallpox in May 1980 provided a strong incentive for them to destroy or transfer their stocks. Since 1984, variola virus has been confined to glass-vials kept under high security in the two WHO Collaborating Centres, neither of which now cultures the virus.

For centuries, the word “smallpox” brought terror to the civilised world as it killed hundreds of millions of people. Dramatic news it was therefore when the World Health Assembly in May 1980 declared the disease to have been wiped out from the Earth. This was the first disease to be totally conquered by man.

Braving the needle in Africa. Smallpox vaccination was soon to become a thing of the past.

Photo WHO

by them. But one animal pox-disease known to affect monkeys kept in captivity was looked upon with suspicion.

The suspicion turned into anxiety when in 1970 a nine-month-old child from a village located in a smallpox-free part of Zaire developed a smallpox-like illness. Surprisingly, monkeypox virus was confirmed by laboratory testing to be the causative agent of the child’s illness. Subsequently, similar cases were detected in other countries of western Africa.

Animal poxviruses—monkeypox: One of the bases on which eradication of smallpox was attempted was the conviction that this specifically human disease had no intermediate host or reservoir of variola virus in animals.

Although a variety of animals suffered from “pox” diseases, man had not been significantly affected by them. It was learned that monkeypox virus, although a distinct species from variola virus, gave rise to an extensive pustular rash, indistinguishable from smallpox. Human monkeypox was not a new disease, but, being rare and so like smallpox, it could never have been recognised until smallpox had been eliminated.

In March 1986 the Committee on Orthopoxvirus Infections took note of the low incidence of human mon-
keypox and the growing conviction that the virus could not sustain itself by man-to-man transmission, and stated that in its view human monkeypox does not pose a significant health problem.

Laboratory investigations and research: Both before and during the post-eradication period, WHO has actively helped to maintain suitable laboratory expertise and laboratory preparedness for unexpected problems that might arise with smallpox but also with other poxvirus diseases of man. Most of the laboratory diagnostic work has been carried out in the two WHO Collaborating Centres in the US and the Soviet Union. Between 1980 and 1986, these two centres alone tested about 22,000 human specimens and about 3,000 animal specimens collected in 36 various, mostly developing, countries. Several unsolved virological and immunological problems relevant to orthopoxviruses merited further research. Assisted by WHO in the post-eradication era, research progressed along two main lines: analysis of the DNA of variola and other orthopoxviruses, and development of reliable sensitive serological tests specific for various species of orthopoxvirus.

Millions of phials of vaccine were produced and distributed around the world.
Photo WHO/J. Mohr

Documentation of the smallpox eradication programme: Since the eradication of smallpox was a unique event in the history of mankind, it was important to document the operational and scientific achievements of the programme, its experiences and the lessons learned in various corners of the globe. WHO published monographs describing eradication in four priority countries: Bangladesh, Ethiopia, India and Somalia. WHO also helped to prepare a monograph dealing with management aspects of the largest national programme, India. A comprehensive reference work entitled "Smallpox and its Eradication", dealing with all scientific, operational and administrative aspects, will be published by WHO in late 1987, about the time of the 10th anniversary of the occurrence of the last case of endemic smallpox.

For centuries, the word "smallpox" brought terror to the civilised world as it killed hundreds of millions of people. Dramatic news it was therefore when the World Health Assembly in May 1980 declared the disease to have been wiped out from the Earth. This was the first disease to be totally conquered by man. The main target of post-eradication surveillance, to provide assurance to the world that it is permanently free from smallpox, has been successfully achieved by WHO and its Member States.

**Human monkeypox**

Because of its close clinical resemblance to smallpox, monkeypox became an important disease for post-eradication surveillance. Since 1970, 400 patients suffering from monkeypox have been recognised in seven countries of western and central Africa; Zaire alone accounted for 95 per cent of them. Most cases occurred in small, remote villages close to or in the forest, where local people have multiple contacts with a variety of wild animals and hunting is important to obtain daily food. Many victims were young children, among whom the case-fatality was similar to that formerly caused by smallpox.

Ecological studies in recent years suggest that squirrels are a significant host or reservoir of monkeypox virus. Large numbers live in the oil-palms which grow between the village and the primary rainforest.

Despite intensified surveillance during the last six years, human monkeypox is viewed as an infrequent and sporadic zoonosis, that is, contracted only by close contact with infected wild animals. However, there have been episodes of transmission from one person to another, between siblings, children and parents, playmates, or patients lying in the same hospital ward. Generally, the transmission stopped spontaneously at the first generation of the cases. Despite waning immunity in the local population, the absence of routine smallpox vaccination, the infrequent nature of human contacts with monkeypox virus and the low transmissibility of the virus may be important factors in limiting its spread.
Smallpox is the first disease to have been eradicated through a concerted global effort. Although this is a stupendous achievement in itself, it also has broader implications for health policy in demonstrating the impact which a community-based programme can have in the field of prevention, the considerable resources that can be mobilised for such an effort, the value of setting measurable goals and monitoring the incidence of disease, and the remarkable cost-benefit advantages of prevention programmes. It is in part because of smallpox eradication that increased emphasis is now being given to disease prevention and health promotion programmes throughout the world. Specific, measurable goals in national and local health programmes are being more widely identified and used in management, and health authorities are increasingly adopting surveillance and sample survey techniques that were elaborated during smallpox eradication.

It was in 1958, that a Soviet delegate to the World Health Assembly proposed that global smallpox eradication be undertaken by WHO, and this was unanimously approved at the following year's Assembly. At that time, 60 per cent of the world's population still lived in areas where smallpox was endemic. During the succeeding seven years, some progress was made in improving vaccine quality and a number of countries became free of smallpox, but the disease, often in epidemic form, continued to be widespread.

Delegates at the Nineteenth World Health Assembly (1966) allocated special funds for an intensified programme starting in January 1967. They proposed a ten-year goal for the achievement of eradication. At that time, an estimated 10 to 15 million cases of smallpox were occurring annually in 31 endemic countries with a population of more than 1,000 million persons. Given that programmes would have to be conducted in most of the least developed countries, that disruptions due to civil strife, famines and floods were inevitable, and that more than a century and a half had already elapsed since Edward Jenner's discovery of a vaccine, the goal was an optimistic one. Nevertheless, the last known endemic case occurred just 10 years, 9 months and 26 days after the programme began.

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The strategy of the programme was two-fold: to vaccinate at least 80 per cent of the population, and to establish systems for surveillance (case detection) and containment of outbreaks. Between 1967 and 1971, WHO-supported national programmes began in all endemic countries and in others that were at special risk of importations. All programmes functioned within the public health structure and each differed from the others in order to cope best with different epidemiological patterns of smallpox, national administrative practices and socio-cultural conditions.

After the occurrence of the last known smallpox cases, health officials in all countries had to be sufficiently confident of eradication that they could stop vaccination. So surveillance programmes and special search activities were conducted for at least two years in every country after the last known case had occurred. At that time, WHO-appointed International Commissions visited and verified the absence of smallpox. Finally, a Global Commission, through a variety of studies, satisfied itself that eradication had been achieved, and its conclusions were endorsed by the Thirty-third World Health Assembly in May 1980.

It is sometimes suggested that the programme should serve as a template for other disease control or eradication campaigns. This is not feasible, because each disease has its own epidemiological characteristics and methods for control which require strategies and tactics unique to that disease. But the rapid progress in eradicating smallpox after so many decades of persistent transmission provides principles and lessons which have implications for other health initiatives.

For a global programme to be undertaken, universal political commitment is necessary and, for this purpose, the World Health Organization and the World Health Assembly were essential. The Assembly uniquely provides the necessary forum for countries to agree on global health policies. WHO, alone among the international organizations, has the requisite scientific expertise and channels of communication with national authorities for the monitoring and coordination of health programmes.

Smallpox eradication could not have been achieved were it not a targeted, time-limited special programme with funds specifically allocated for it, both in the WHO budget and in most national budgets, and with full-time technical staff responsible for its supervision. Yet some argue, even today, that special programmes are inherently poor policy, serving only to divert resources and attention from the development of primary health care systems. That such programmes can make important contributions to the development of national health
Dr D.A. Henderson, then chief of WHO's smallpox eradication unit, examining vaccination scars during casefinding operations in Ethiopia.

Right: Village children wait in the rain in an Indonesian village for the mysterious prick of a needle that would protect them.

Photos WHO and WHO/C. Frucht

services was demonstrated by the smallpox eradication programme. In part, this is because it functioned within the existing public health structure rather than as an entirely separate entity as was the case with the earlier (and unsuccessful) malaria eradication campaign. It was thus obliged to work with and through the existing administrative health structure and to coordinate its activities with other programmes.

In addition, a specially dedicated and trained professional smallpox eradication programme staff was necessary at all levels to design and coordinate the programme; to develop reporting and surveillance systems; to undertake case-detec-
The lessons learnt

tion and containment measures, and to train local health staff. There was a need to seek the support of village leaders and, through them, the acceptance and participation of the population.

The observations have important implications to the strategy for providing what is called primary health care. Such care is usually regarded as a closely related set of services, all delivered in a similar manner, but experience suggests that it would be better conceptualised as consisting of two different but complementary components. One of these involves the traditional, primarily curative activities; the second involves those services intended to reach individuals throughout a community, including both preventive interventions (such as immunization or family planning) and curative ones (such as oral rehydration therapy). The traditional health care system may serve as the base for both functions but different types of programme, different personnel skills and different methods of assessment are required for each activity. Traditional, curative services can be provided in established health units by clinically-trained physicians and nurses, and are usually appraised in terms of the training of the practitioners, the quality and sophistication of facilities and the numbers treated. Community-wide programmes require active outreach by persons skilled in management and public education in order to ensure acceptance; the provision of services at a site and time convenient to their clients; and methods such as surveillance to measure success in diminishing morbidity, mortality or fertility.

Special purpose programmes identifying the achievement of certain objectives, usually within a finite period of time, are generally better supported and financed than are programmes with less explicit goals. Experience shows that a programme to eradicate smallpox or to prevent poliomyelitis, for example, has more popular appeal than one to develop the basic health services. Such special-purpose programmes are particularly important to public health because it is almost always more difficult to obtain support for public health programmes than for curative services. This reflects a
reality that political leaders are usually more readily persuaded to provide funds for the more tangible curative services (hospitals and health centres) than for community-based programmes.

A finite end-point—the nil incidence of smallpox—undoubtedly was important in motivating staff and sustaining interest. Though few health programmes have such an end-point, comparable levels of achievement, interest and morale should be possible where specific goals are identified, where progress is monitored and where programme staff are fully supported in their efforts.

Extraordinary achievements are possible when countries throughout the world pursue common goals within the structure provided by an international organization. WHO played this role in the eradication of smallpox. It now offers a unique—although only partially realised—potential in promoting other efforts in disease prevention and health promotion. It is an organization which can demonstrably catalyse achievements far out of proportion to the resources it commands. The extent to which it is successful will depend upon the confidence it merits from its Member States, on the effectiveness of its leadership in enunciating clear and measurable objectives and in mobilising support to attain them, on the number and competence of its professional staff, and on its ability to set aside extraneous political agendas. WHO's ability to respond appropriately will determine the degree to which it succeeds in the future in providing improved health and a better quality of life for all the world's people.

Where there's a will, there's a way.
Helping the surveillance team's vehicle on its way in Thailand.

Photo WHO/T. S. Satyan
Progress in the right direction

by Isao Arita

Whilst I was travelling in western and eastern Africa during the smallpox eradication campaign in the 1970s, I often encountered a patient with a malignant tumour of the jaw in the hospitals which I visited. Later I realised that this was Burkitt's lymphoma, a monoclonal tumour of B cells. Denis Burkitt had travelled extensively in tropical Africa in the early 1950s and had established the entity of this special disease.

I have no intention of telling the whole story of Burkitt's tumour here, but it came to mind because I was once very much impressed by his brief essay entitled "Great progress but in wrong direction" which Lancet published in December 1984.

In it he wrote: "Newspapers and television have reported the insertion of a non-human primate's heart into a baby and the implantation of a plastic heart into an adult man as if these were landmarks in medical progress. But are they?"

"All the really major advances in health care have been in the realm of prevention. Probably the greatest health achievement in this century has been the elimination of smallpox. In 1967, there were an estimated 10 to 15 million new cases with an estimated two million deaths; now the disease is non-existent. The cost of this achievement, spread over ten years, was around US $300 million. This is less than the amount spent every two months in the United States on coronary by-pass surgery or on removing gallbladders—both operations for potentially preventable diseases."

As Denis Burkitt pointed out, there are two principal lessons to be learnt from WHO's Smallpox Eradication Programme (SME). The first is that prevention is far better than treatment, and the second is that international cooperation is of the utmost importance. These lessons—simple as they are—should be applied to the control of chronic diseases in industrialised countries as well as to the child survival programme in developing countries.

I retired from WHO in 1985 and now manage a national hospital of 550 beds in Japan. When I returned to hospital work, I was astonished by the tremendous progress made in clinical medicine during the past two decades with such processes as automation of diagnostic techniques, imaging diagnostic methods, hyperalimentation, anti-microbe treatment and organ transplants. Yet these treatments, requiring expensive equipment, are being used to manage the diseases of patients whose full recovery could not be expected because they are mostly of advanced age and suffering from all sorts of complications.

In Japan, 600,000 persons die every year, 80 per cent of them from cardiovascular diseases or malignant tumours. As old persons form an ever-increasing proportion of the total population, these conditions will result in a substantial increase in medical costs. Under these circumstances, it is highly significant that primary and secondary preventive measures against these diseases have been developing very rapidly, as Sir Richard Doll noted in an address to a learned London society in October 1982. He suggested that prevention would be the best method of coping with current medical problems and its importance would increase toward the end of this century.

In order to further strengthen its aid programme, Japan's International Cooperation Agency last autumn dispatched a few teams to South-East Asian countries, the United States and Europe to study international health policy, especially on a bilateral basis. I was a member of one of these teams and observed as an outsider (not as a WHO official) the latest trends in international health. I was surprised to see the extensive and vigorous campaign called the Child Survival Programme. This programme is a joint effort of WHO, UNICEF, the World Bank, governments (bilateral assistance from the US and West European countries) and non-government organizations (Rotary International, the Rockefeller Foundation and so forth) to reduce the tragic mortality rate of children in the Third World.

It is heartening to see that, in this global programme, the main emphasis was placed on the Expanded Programme on Immunization and on Diarrhoeal Disease Control. As is quite well known, these two programmes have been initiated, strengthened and encouraged by the success of SME. Many staff members in those programmes were among those who originally worked for the smallpox eradication programme.

Let me cite one episode in relation to this. During my trip to the US I met the staff from WHO's Office of the Americas who were carrying out the poliomyelitis elimination programme in the region. Many senior staff for this programme, both at the WHO Regional
It is heartening to see that, in the vigorous global campaign known as the Child Survival Programme, the main emphasis was placed on immunization and diarrhoeal disease control—two programmes that have been initiated, strengthened and encouraged by the success of WHO's smallpox eradication campaign. Many staff members in those programmes were among the thousands of helpers who worked for the eradication of smallpox.

The year 1987 marks the tenth anniversary of the occurrence of the world's last endemic case of smallpox. During the last ten years, innumerable problems have arisen in carrying out various health programmes. But the success of the smallpox eradication programme will always give us grounds for optimism, and faith in the view that international public health efforts can and will eventually be crowned with success.
The poorest had most to gain

by Jarl Tranaeus

Sweden helped to finance WHO’s Smallpox Eradication Programme because it was a venture that fell exceptionally well in line with Swedish development assistance policies. Those policies were laid down by Parliament 25 years ago, and they were reaffirmed and amplified in 1968 when the decision was taken that one per cent of Sweden’s gross national product should be appropriated annually to development assistance.

The established aid objectives are to promote economic growth, economic and social equality, economic and political independence and the development of democracy in society. No single objective takes precedence when it comes to carrying out the policies in the 17 countries which are today regular recipients of Swedish bilateral assistance. In each country, an attempt is made to arrive at a mix of objective-oriented projects and programmes which take into account the direction of that country’s own development plans.

As the 17 countries are all among the least developed in the Third World, there is considerable scope for efforts aiming to improve life for the poor, the vast majority of whom live in the remote countryside. Experiences over a quarter-century have shown, however, that projects and programmes to promote economic and social equality are difficult to design and even more difficult to implement successfully. Examples are manifold. Typically, rural development or work projects may turn out to be of benefit not to the prime target group but to those on a higher rung of the poverty ladder and having access to the local power base. The poorest have no effective spokesmen and are at a disadvantage in community politics, where dispensation of services or benefits hinge on caste, tribe or land ownership.

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Smallpox eradication offered a very different opportunity for a donor to become involved in an undertaking of real benefit to the poorest. The vast majority of smallpox victims, actual as well as potential, were the truly poor and underprivileged; those with no access or limited access to health facilities, those weakened by malnutrition, those most vulnerable in the battle for survival. This is why Sweden responded positively when invited by WHO to help to finance the death of smallpox.

It all began at the end of 1973, when I was Head of Development Cooperation at the Swedish Embassy in New Delhi. I was approached by members of the Smallpox Eradication Project, working out of WHO's South-East Asia Regional Office in New Delhi. Would Sweden be willing to provide finance for a programme aiming to wipe out this killer disease? India was at the focus of such a programme, for at that time the country accounted for some 80 per cent of all known smallpox cases in the world.

The target Smallpox Zero stirred our imagination: here was the prospect of eradicating a disease which had plagued mankind for two thousand years. Equally impressive was the conviction that the strategy drawn up was right and that, given the necessary finance, the job could be done.

I contacted the headquarters of SIDA, the Swedish International Development Authority, endorsing the proposal, and their response was equally positive. A formal request from the Government of India was obtained with unprecedented swiftness, and the Swedish Government made its decision shortly thereafter. At the same time, Sweden provided funding for the eradication programme in neighbouring Bangladesh. Additional finance to the India programme was made available on two occasions, and Sweden also contributed to the final effort in Africa.

The conduct of the campaign in India is well documented. Let me just record that, on a field trip in early 1975, I saw what was probably one of the last cases of smallpox in India. This was a young boy who had been hidden away by family elders when their household members were vaccinated. The only village inhabitant later to contract the disease, he was living testimony to the correctness of the containment strategy.

Sweden's confidence in WHO and in that strategy was amply justified. In 1977 India was officially declared free of smallpox and, not long afterwards, global eradication was proclaimed.

This was a unique achievement. No longer will smallpox claim lives or deprive human beings of eyesight; by the middle of the next century there will be very few, if any, disfigured survivors of the disease to remind mankind that smallpox once existed. And the principal beneficiaries of this achievement are the poorest and most disadvantaged in all countries, because it was among them that smallpox took its major toll.

Facing page: Checking a baby’s vaccination scar in Kenya.

Below: Pockmarked feet of a victim during a 1972 smallpox outbreak in Yugoslavia.

Photos WHO/C. Simayu and WHO/D. Egli

The preservation of lives and the relief of human suffering cannot be measured in monetary terms. But the eradication of smallpox also brought very quantifiable benefits. Sweden's contribution to the WHO component of the programme in India was of the order of US $8 million, which was small in comparison with the costs borne by the government of India and state governments. Once global eradication was confirmed vaccination was no longer necessary and the resulting annual saving in India exceeded the total cost of the 1973-1977 campaign. In the United States alone, the annual expenditure associated with vaccination requirements was $150 million. So by any cost/benefit calculation, the global eradication of smallpox stands out as a singularly successful programme.

This success gave encouragement to further programmes aiming at disease control or eradication, and also raised expectations about the role to be played by WHO. Sweden has supported WHO-executed programmes in malaria, leprosy and tuberculosis in India, and has also helped to fund international research programmes on communicable diseases under WHO auspices.

The last few years have alerted the world community to the frightening threat of AIDS, a disease for which no cure is yet known and which, if unchecked, may become a global plague even before the end of this century. This crisis calls for both national and international efforts on an unprecedented scale—and the Third World in particular will no doubt expect WHO to play a leading role in coping with it.
Dr Jenner’s legacy

It was in 1796 that an English country doctor, Edward Jenner, discovered the principle of vaccination. By 1801 more than 100,000 persons had protected themselves with his vaccine, and he predicted that “the annihilation of the smallpox—the most dreadful scourge of the human species—must be the final result of this practice.” In the end it took 183 years and a huge international effort, under the aegis of WHO. But Dr Jenner was proved right.

Jenner (right) even left his mark on the moon, where a crater bears his name.

Above: In the 1870 Franco-Prussian war, the Prussians were vaccinated but the French were not—and suffered many deaths.

Above: Jenner demonstrates his vaccine, and a 16th century Mexican painting of smallpox victims.

Above: Search teams used every kind of vehicle, and offered cash rewards, to track down the last case in Bangladesh, three-year-old Rahima Banu, and—in Somalia in 1977—the world’s last endemic case, Ali Maow Maalin. Below: Every rumour was checked on, but proved to be chickenpox or other diseases.

Right: The Certificate of Global Eradication.
The USSR proposed to the 11th World Health Assembly that smallpox should be eradicated and this was approved in 1959. The programme was greatly intensified in 1967, and in four years had wiped out smallpox in Latin America. Four more years toppled the disease’s last bastion in Asia. The multi-national teams closed in on Somalia, scene of “the last stand”. In December 1979, an independent commission confirmed the eradication of smallpox from the planet.

**What next?**

Lifting the heavy yoke of smallpox from a long-suffering world was probably the greatest health achievement of this century. Besides encouraging many advances in producing and safeguarding vaccines, it showed the impact that community-based action can have on preventive health, particularly when backed by political will at the highest level. The next step is to harness the same international will and energy to bring about the whole package of educational, environmental, behavioural, medical and managerial actions that WHO calls Health for all by the year 2000.
Can smallpox return?

by Frank Fenner

The last case of endemic smallpox in the world occurred in October 1977 and the last case of smallpox (a laboratory-associated case) in August 1978. In spite of careful scrutiny of all rumours of suspected smallpox, no case has been recognised since then.

A review of all the sources from which infection could occur again suggests that any such possibility is remote, but it is absolutely impossible to exclude the unwitting storage of variola virus in a deep-freeze cabinet, theft from a known laboratory stock, or its deliberate secret storage for possible use as a weapon of biological warfare. However, even if an outbreak of smallpox were to arise from any such source, it could be readily controlled by surveillance and containment, unless public health services had completely broken down.

When the global smallpox eradication programme was first proposed in 1958, endemic smallpox had been eliminated from all the countries of Europe and North America and from several countries in other continents. There was therefore a prima facie case that, once the cycle of human-to-human transmission had been broken in all countries of the world, the disease would not recur. However, from the outset of the Intensified Smallpox Eradication Programme the newly-created Smallpox Eradication Unit in WHO Headquarters in Geneva, and both WHO and national staff undertook to make an accurate diagnosis of every suspect case or rumour, supported by the diagnostic expertise of the WHO Collaborating Centres in Moscow, USSR, and Atlanta, USA. Since 1980, 131 rumours have been investigated, excluding cases of monkeypox in western and central Africa. None was smallpox. The commonest clinical conditions that were confused with smallpox in the post-eradication era (as indeed when smallpox was endemic) were chickenpox and measles.

Concurrently with the need to explore the possibility of an animal reservoir, from 1971, when the last case was reported in South America, the Smallpox Eradication Unit had to show convincing evidence that smallpox had indeed been eliminated from countries, including those with poorly developed health services, from regions, from continents and finally from the world.

Dr Frank FENNER, Emeritus Professor in the John Curtin School of Medical Research, Australian National University, Canberra, was Chairman of the Global Commission for the Certification of Smallpox Eradication, 1978-1980.

So it started a scheme for the certification of smallpox eradication which rapidly developed into a highly efficient system that coped successfully with the difficult problems of certification in the countries of the Indian subcontinent and the Horn of Africa. Subsequently a Global Commission for the Certification of Smallpox Eradication was established, whose ultimate aim was to convince the World Health Assembly that smallpox had indeed been eradicated worldwide, so that vaccination against the disease could be discontinued everywhere.

On 9 December 1979 the Global Commission formally adopted a 122-page Final Report, which concluded that smallpox had been eradicated worldwide, and included a number of recommendations for the post-smallpox eradication era. This report and its conclusions and recommendations were adopted by the World Health Assembly on 8 May 1980. Over seven years have elapsed since that declaration, ten years since the last case of endemic smallpox (variola minor) occurred in Somalia, and 12 years since the last case of endemic variola major occurred in Bangladesh.

Is there any evidence that smallpox has recurred after its supposed elimination from a country? To investigate this, an International Rumour Register was maintained at WHO Headquarters in Geneva, and both WHO and national staff undertook to make an accurate diagnosis of every suspect case or rumour, supported by the diagnostic expertise of the WHO Collaborating Centres in Moscow, USSR, and Atlanta, USA. Since 1980, 131 rumours have been investigated, excluding cases of monkeypox in western and central Africa. None was smallpox. The commonest clinical conditions that were confused with smallpox in the post-eradication era (as indeed when smallpox was endemic) were chickenpox and measles.

However, two laboratory-associated cases occurred in Birmingham, England, in 1978. On 27 August of that year, the British health authorities reported that a medical photographer in the University of Birmingham was suffering from variola major. Since she worked in rooms immediately above a
laboratory in which WHO-sponsored research with variola major virus was being carried out, it was clear that the infection was laboratory-associated, although the exact route of infection was never determined. The woman unfortunately died—the last ever victim of a disease that used to kill millions. The only secondary case was a very mild attack in the photographer’s mother. This incident alerted medical authorities throughout the world to the potential dangers of infection from laboratories in which variola virus was being used.

Many laboratories used to carry stocks of variola virus as an aid for diagnosis. In response to enquiries by WHO in 1975, no fewer than 75 laboratories confirmed that they then held stocks of the virus, but following a recommendation that only WHO Collaborating Centres for Poxvirus Research should hold the virus, this number was reduced to 18 by July 1977. The Birmingham outbreak led to a further reduction to seven laboratories at the end of 1979, and by 1983 only the WHO Collaborating Centres for Smallpox Diagnosis in Atlanta and Moscow held stocks of the virus. Both of these are high security laboratories and they are regularly inspected by WHO experts in microbiological safety. In spite of the very small risk of escape from such laboratories, a WHO committee that met in March 1986 suggested that WHO should recommend that these stocks should also be destroyed. This suggestion was based on the fact that cloned preparations of variola virus DNA are now available, which are safe to handle in open laboratories and could be used in any emergency for comparative studies of the nature of an orthopoxvirus.

Smallpox due to variolation—using material from a victim's scabs to confer "immunity" on others—caused outbreaks in China in the early 1960s, and outbreaks associated with variolation were a problem in the eradication campaigns in Afghanistan and Ethiopia. In Ethiopia, variolation was practised only in the face of an outbreak of smallpox, using material from an early case. With the elimination of the endemic disease in 1976 the likelihood of continuing variolation disappeared. In Afghanistan and China there were many professional variolators and they used stored material which they regularly replenished with fresh scabs, since they found it unreliable for more than a year. But outbreaks ceased once the activities of the variolators stopped.

Five other possible sources for a return of smallpox can be envis-
aged: an animal reservoir, viral persistence in the environment, transformation of another orthopoxvirus into variola virus, reactivation and excretion in a human subject, and deliberate release.

In 1959 a disease of monkeys had been reported that closely resembled smallpox, and was caused by an orthopoxvirus. A group of expert virologists was called together in 1969, and met biennially thereafter, to discuss various technical problems relating to orthopoxviruses and to consider especially the disease monkeypox, and any evidence relating to an animal reservoir of variola virus. Their activities received a stimulus in 1970 when it was discovered that, in central and western Africa, monkeypox virus caused a sporadic, smallpox-like disease in humans. But the new "genetic engineering" technology has proved that variola virus could not be derived from monkeypox virus, and the conclusion among virologists is that there is no animal reservoir of variola virus—smallpox was a specifically human disease.

Variola virus is very resistant, and viable virus has been obtained from scabs kept in a European laboratory 13 years after they were collected, although it was unlikely to have had sufficient strength to infect humans. This belief is supported by interviews with variolators in Afghanistan, who reported that scabs which they had collected were seldom able to induce infection after one year, even when stored at moderately low temperatures. But could the virus survive in vials stored in a deep freeze in a laboratory, or in the corpse of a fatal case of smallpox that has been deep frozen in an Arctic region? Three instances of unwitting storage in a deep freeze cabinet of what was probably variola virus have come to the notice of WHO since 1979: one in Tanzania, one in California and one in the United Kingdom. In all cases the ampoules were immediately autoclaved.

The excavation of the remains of persons who have died of smallpox, in towns in Europe, for example, is much more frequent than the likelihood of discovering a long-frozen corpse of a smallpox victim, but this carries a negligible risk of surviving viable virus, since most such remains consist only of bones. In 1986, poxvirus particles were indeed identified by electron microscopy in the skin lesions of a mummified child who died of smallpox in Italy in the sixteenth century. But careful testing showed that the poxvirus particles were not viable.

In the early days of virology, it was believed that variola virus could be "transformed" into vaccinia virus by passage in cows, and more recently some Soviet virolog-
ists suggested that monkeypox virus might have been "transformed" into variola virus. However, studies of the DNA of the accepted species of the genus Orthopoxvirus show that the differences between the DNA molecules of each species are too great for such a "transformation" to occur.

Some viruses, such as the herpes viruses, persist for life in infected persons and at intervals are reactivated and cause the subject to become infectious for others. Poxviruses, as a group, do not exhibit this type of behaviour. If such reactivation were to occur, it would be most likely in patients subject to immuno-suppression, either by chemotherapy or because of a malignant disease of the lymphoid system. No such occurrence has even been recognised, and this potential source can be excluded.

**Deliberate Release**

In 1973 many nations signed a convention outlawing the production and use of biological weapons. Unfortunately, this does not completely exclude the possibility that variola virus might be deliberately released as a means of warfare. But the risk of the re-establishment of endemic smallpox should not be exaggerated. Smallpox spreads comparatively slowly, by face-to-face contact. Unless the public health services had completely broken down, the existence of reserve stocks of vaccine and the capacity for production of vaccine would ensure the containment of any outbreak that followed a deliberate release of variola virus.

With the cessation of vaccination and vaccine production, it will become increasingly difficult for any person or group contemplating the release of variola virus to assure themselves and their colleagues of protection against smallpox. Resumption of vaccination against smallpox by a country could legitimately be interpreted as a sign that it might be considering the use of variola virus for aggressive purposes.

Deliberate release or the threat of it by an individual or group, as an act of sabotage or terrorism, cannot be absolutely excluded, although the possibility is remote because access to the virus is so restricted. The existence of such a possibility underlines the need for maintaining "military" as well as microbiological security in the two laboratories still holding variola virus stocks or, better, the destruction of all such stocks.

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**International Rumour Register**

In compiling its International Rumour Register, who recognised that prompt reporting, investigation and diagnosis of all reports or rumours of suspected cases of smallpox are essential tools for maintaining the public confidence in the fact of eradication. Assistance in this investigation and the collection of specimens for laboratory testing has come from state and regional health departments, often staffed by veteran smallpox fighters.

The time required for national health authorities to investigate the suspected cases varied considerably, partly depending on the apparent seriousness of the reports.

For example, a report from Kenya caused some public health concern because the patient, who died three days after developing a rash, had been a traditional healer, perhaps an ex-variolar who had used material from smallpox patients to inoculate others at a time when smallpox was still endemic in his area. Prompt investigation and collection of specimens by Kenyan health officials and rapid laboratory investigation proved within a week that he had chickenpox.

On the other hand, information provided at a meeting of an international organization required nine months of investigation to establish that rumours of smallpox in several countries of sub-Saharan Africa were false.

Rumours of smallpox, especially those generated by the media, could spread rapidly and cause international concern. Ironically, one "doctor-confirmed" rumour arose at an international health seminar in Ixtapa, Mexico, in 1985, where 250 delegates were warned to see their doctor upon returning home because a delegate had been diagnosed by a hotel doctor as having smallpox. The rumour circulated abroad before a diagnosis of chickenpox was confirmed by the WHO collaborating laboratory.

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**Suspected cases of smallpox reported to WHO Headquarters, Geneva, 1980-1986**

<table>
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<tr>
<th>WHO Region</th>
<th>1980</th>
<th>81</th>
<th>82</th>
<th>83</th>
<th>84</th>
<th>85</th>
<th>86</th>
<th>Total</th>
<th>Chickenpox</th>
<th>Measles</th>
<th>Skin disease</th>
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<td>Africa</td>
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<td>11</td>
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<td>11</td>
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<td>8</td>
<td>8</td>
<td>5</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>0</td>
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</tr>
<tr>
<td>Eastern Mediterranean</td>
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<td>2</td>
<td>1</td>
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<td>0</td>
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<td><strong>10</strong></td>
<td><strong>131</strong></td>
<td><strong>54</strong></td>
<td><strong>19</strong></td>
<td><strong>16</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

1 In statistical reports, or by the news media.
only two years after the world's last case of endemic smallpox occurred in Somalia, in October 1977, WHO was able to make the official declaration of global smallpox eradication. Throughout this period a continuous search was undertaken for possible hidden cases in the areas where the disease had previously been endemic.

This thorough and comprehensive search relied heavily on laboratory investigations of all suspect cases, since it was often only the laboratory that could show whether the disease was smallpox or not. Thousands of such investigations were carried out on smallpox suspects from dozens of countries at the two institutions supremely qualified in the laboratory diagnosis of pox infections, namely, the WHO Collaborating Centres in Moscow (Moscow Research Institute for Viral Preparations) and in Atlanta, USA (Centers for Disease Control). These investigations gave negative results for all suspected cases: not a single case of smallpox has been revealed.

The data obtained provided the major premise that enabled the Global Commission for the Certification of Smallpox Eradication, which had been created by WHO, to confirm that the whole planet was “clean”. In the Commission's report, recommendations for the post-eradication era occupy a special place, because of the need to give the public evidence that smallpox will never reappear and that mankind is not endangered by other poxviruses.

Dr Svetlana MARENNIKOVA is Chief, WHO Collaborating Centre on Smallpox and Related Infections, Laboratory of Viral Vesicular Infections, Moscow Research Institute for Viral Preparations.

Laboratory work combining both diagnosis and research formed a substantial element in this post-eradication surveillance programme. The diagnostic part was in effect a continuation of similar work carried out during the closing stages of the eradication campaign, when it related to patients suspected to be smallpox cases.

In the past decade we at the Moscow Collaborating Centre were involved in investigating rumours about smallpox, some of which reached the press and thus aroused the natural concern of the public. In all these cases, WHO was eager to obtain from the collaborating centres the results of laboratory study of materials taken from the patients in question. To our general satisfaction, the rumours have never been proved true.

It is appropriate here to make a small digression. During the campaign the laboratories performing the diagnostic work that was needed in order to identify new viral isolates used to use laboratory strains of the variola virus. At our laboratory and elsewhere, the peculiarities of variola virus strains isolated in different geographical regions were studied. This work not only enlarged our knowledge of the variola virus but also made it possible to explain the difference in the clinical course of the so-called “Asian” smallpox and “African” smallpox. The research undertaken in other laboratories involved a comparative analysis of variola and other orthopox (especially monkeypox) virus genomes. As a result of this long-term work with variola virus, a vast collection of its strains was gathered in some laboratories.

After smallpox transmission stopped, the stocks of strains preserved in laboratories turned out to be a real potential hazard for the reappearance of smallpox.

The small number of laboratory-acquired smallpox cases testify to the fact that work with variola virus without appropriate precautions always presents a danger for those who handle it as well as for other people. A threatening reminder was

Sealed refrigerator at the WHO Collaborating Centre in Moscow where variola virus strains are stored. Besides a lock and a seal, it is fitted with a sound alarm.

Photo WHO/S. Marennikova

WORLD HEALTH, Aug./Sept. 1987
steadily vanishing immunity to smallpox. This very fact has undertaken a complex of measures to exclude such a possibility. The first step in this direction was to reduce the number of laboratories maintaining variola virus strains. This process started even before the campaign was completed. In 1976 there were 76 such laboratories, but today there are only two, both acting as WHO Collaborating Centres.

The stocks in other laboratories have either been destroyed (in most cases) or transmitted to one of the two centres.

Besides this, in 1977 WHO began to develop biological safety requirements for laboratories dealing with or preserving variola virus. After some improvements, these requirements provided appropriate safeguards both for people handling the virus and for those in the vicinity. WHO inspection teams regularly check that these requirements and virus storage regulations are fulfilled. It should be added that research into variola virus has actually stopped within the last two years. Now the question arises whether we must continue maintaining stocks of variola virus or destroy them.

A no less important part of laboratory research in the post-eradication era was the study of human monkeypox, a disease "discovered" in Equatorial Africa in 1970. Its striking feature is the similarity of the clinical picture to that of smallpox. This very fact accounts for the close attention paid to this disease and the need for it to be investigated in the framework of a special WHO project. Some questions still remain to be answered about the development of infection in human beings, the ecology of the virus and the potential danger of monkeypox under conditions of a steadily vanishing immunity to smallpox. As a result of activities organized and coordinated by WHO between surveillance teams in some African countries and laboratory work at the collaborating centres, it has been established that human monkeypox is a rare zoonotic disease, but the geographical area where it can be encountered is a large one and covers the tropical rain forests of Equatorial Africa. Most patients (75.1 per cent) get infected from animals—the natural carriers of the virus. In 18.6 per cent of cases, the source of human monkeypox under conditions of close contact was the infected person (second infection generation). Transmission to the third generation was very rare (less than seven per cent), and only once in 17 years was a fourth generation infection found. Results obtained so far confirm the initial data showing the small contagiousness and transmissibility of monkeypox in comparison with smallpox.

An important step in the monkeypox study was the detection of a natural reservoir of this infection. For a number of years, efforts in this direction failed to give any perceptible results. Only by the end of 1985 did the combined investigations carried out by WHO epidemiologists and virologists from the collaborating centres result in the discovery of the virus reservoir. It turned out to be some species of tropical squirrels.

The long-term (17-year) study of monkeypox isolates obtained from patients in various African countries showed the pathogen to be quite stable and not prone to any substantial variability. However, it seems reasonable to maintain periodical control of the properties of this virus in the future.

Among other orthopoxviruses (besides vaccinia virus), the cowpox virus is pathogenic for humans. During the years of post-eradication surveillance, our knowledge of the ecology of this virus was extended. The most interesting thing here is that we had to change our opinion about the natural reservoir of this infection. It has been proved that the carriers of the virus in nature are small rodents. It also appeared that the cowpox virus possesses a wide range of pathogenicity and can affect individuals of the majority of taxonomic groups of animals. Recently the possibility of human cowpox infection caused by contact with sick rodents was demonstrated. The feature of this infection and its contagiousness has not changed since Jenner's time, and it is only harmful to human health in special cases, for instance, when it affects the eye.

The overall conclusions of the surveillance and research into orthopoxvirus infections conducted during the post-eradication period are that smallpox itself has completely disappeared and that other orthopoxviruses, including monkeypox, do not present a danger for public health.
People's eyes tend to glaze over the minute they hear the words “cost benefit analysis.” We all want to be convinced we are getting value for money, but in this case the benefit is more apparent than the cost.

Everyone knows that smallpox was a truly dreadful disease which literally terrorised mankind for thousands of years, and that, through international cooperation, the disease has been totally eliminated. Everyone thinks, “Ah, yes. This is a good thing.” The benefit is obvious.

But then “everyone” did not have to pay for it; that was something to do with WHO, donor agencies and governments. Did we get value for money?

WHO calculates that the following costs for eradicating smallpox were incurred by the international community over the 13 years from 1967 to 1979:

<table>
<thead>
<tr>
<th>Estimated expenditure</th>
<th>1967-1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>International sources</td>
<td>US $</td>
</tr>
<tr>
<td>WHO regular budget</td>
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</tr>
<tr>
<td>WHO voluntary fund</td>
<td>37,643,037</td>
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<tr>
<td>Other agencies</td>
<td>2,492,328</td>
</tr>
<tr>
<td>Bilateral assistance</td>
<td>24,269,124</td>
</tr>
<tr>
<td></td>
<td>97,969,737</td>
</tr>
</tbody>
</table>

These figures are necessarily estimates, so let us say that international input was $100 million, of which 70 per cent was channelled through WHO.

How much did countries spend themselves? This is less easy to estimate, as we have to compare the amount a given country was spending each year on on-going smallpox control with the amount it spent over a limited period on the eradication campaign. The amount routinely spent on control, in reality, counts as a saving (“the benefit”) as a result of eradicating the disease.

The ratios of international to national input into smallpox eradication were, in Bangladesh 1:1, in Ethiopia 10:1, in India 1:3, and in Indonesia 1:2. Let us assume for the other countries of Africa a ratio of international input to national input of 2:1, an equal share for South America, and equal or two times international spending per national spending in the rest of Asia, and we arrive at a total for national input that is at least equal to the international input of $100 million.

Another way of looking at the problem is to note that India, nationally, spent $50 million to eradicate smallpox, money spent in this field before 1973 considered as being allocated to “control”. In 1967, India accounted for half the population of the 31 smallpox-endemic countries. Two times $50 million equals $100 million, or the equivalent of the international input.

It is reasonable to conclude that the total cost to the world of smallpox eradication was as little as $200 to $300 million.

The obvious basic saving resulting from eradicating smallpox comes from being able to stop vaccinating. A study performed in the
United States estimated that in 1968 it had cost $150,118,000 to vaccinate 7.2 per cent of the population including producing and administering the vaccine, treating complications, indirect costs from death, disability and loss of earnings from complications, and administration of traffic and maritime clearances. Of the total, $92,800,000 was for vaccine and its administration. In addition, there were indirect costs equal to 46 per cent of this figure.

Let us leave out traffic clearances. Let us assume all countries were vaccinating to some extent and calculate the cost based on each country’s per capita gross national product (GNP) relative to the United States. Then we convert the sum to 1979 dollars, since, if eradication had not been achieved, that is the level at which money would still have been being spent. It comes to $783,284,510. Add 46 per cent for indirect costs in the industrialised world (thus excluding developing countries) and you arrive at $1,000 million per year!

This saving of $1,000 million per year is necessarily speculative, and it takes no account of the sickness and death that smallpox would have caused.

To estimate the value of not having smallpox cases, we may look to a study in India based on 1971 prices. The cost associated with mortality was based on loss of productivity at $900 per death, adjusted for age, sex, life expectancy and distribution of cases. The cost of morbidity was based on loss of productivity during 17 days. Treatment costs are not considered here. The number of cases of smallpox reported throughout the world in 1967 is thought to be in the neighbourhood of only one per cent of those actually occurring. To be conservative, we shall assume two per cent reporting. Pro-rating other countries reporting cases of variola major against India’s per capita GNP and life expectancy, and then adjusting to a 1979 dollar value, we arrive at an estimated annual saving of $1,500 million—give or take a few hundred million.

To sum up—if you have managed to get this far—an investment of some $200 million resulted in a saving—or rather, prevented a recurrent annual burden—of $1,000 million plus $1,500 million equals $2,500 million. An annual return on your investment of 1,250 per cent! If putting a cash value on human suffering makes you uncomfortable, it still works out to an annual return of 500 per cent. Now that’s what I call getting your money’s worth!
Spin-off from space travel

Food associated diarrhoeal diseases are preventable and need not occur. The concept of the hazard analysis critical control point (HACCP) is the most viable means to this end yet devised by Silvia Michanie and Frank L. Bryan

It was in order to provide absolutely safe foods for astronauts while travelling in space in the 1960s that the hazard analysis critical control point (HACCP) concept evolved in the United States. During the following decade, the HACCP approach was adopted by the US Food and Drug Administration in cooperation with the food-processing industry as a means of providing safe low-acid canned foods.

Since then, many food processors and some food-service operators have found that the HACCP approach does not only provide a high degree of assurance of food safety and quality; it is also economically advantageous. It is rational since it is based on historical data about causes of illness and spoilage; it is comprehensive in that it relates to ingredients and subsequent use of products as well as to the process; it is continuous in that problems are detected when they occur and action is taken then to correct them; and it is systematic in that it is a comprehensive plan covering step-by-step procedures. And it offers greater assurance than either testing final products or making periodic inspections.

By hazard we mean the unacceptable contamination, growth or survival of micro-organisms that might cause illness or spoilage, and/or the unacceptable production (or persistence in foods) of toxins of microbial metabolism. Severity is the magnitude of the hazard or the degree of consequences that can result when a hazard exists. Risk is an estimate of the probability that a hazard will occur.

A critical control point is an operation (practice, procedure, process or location) or a step of an operation at which a preventive or control measure can be exercised. This measure will eliminate, prevent or minimise any hazard that has occurred prior to this operation.

The criteria that ensure control at critical control points are specified during hazard analyses, sources and modes of contamination are sought. Measurements establish whether disease-causing microbes survive cooking or other processes, and whether they multiply during intervals between preparation and ingestion. Certain foods may or may not lend themselves to supporting the growth of microbes. Samples may be collected and analysed for the presence and quantity of disease-causing and/or spoilage microbes. Each step of the food flow is considered and illustrated on a diagram, with the hazards and critical control points highlighted.

Answers have to be found to a number of questions. For instance, what are the raw ingredients? What is the pH (degree of acidity) of the final product? What is the time-temperature exposure of the product during processing of preparation? Will the product be eaten immediately after preparation, or will it be stored hot, cold or at ambient temperature?

This looks rather sophisticated for use in homes, yet these analyses have been conducted in homes in a capital city, an island city, a suburban shanty town, a mountain pueblo and a rice-farming village. The variety of these settings provides a stringent test of the validity of the approach, and it has passed the test.

In addition to contamination that may be specific to certain kinds of raw food, such factors as traditions, education, economic resources, sanitary facilities, personal hygiene and environmental sanitation may further contribute to hazards during preparation, when food is kept after being cooked, or while leftovers are handled. The
Hazard analysis involves finding out whether disease-causing microbes survive cooking or other processes. A hospital kitchen in Santiago, Chile.

Photo WHO/P. Almasy

Hazard analysis involves finding out whether disease-causing microbes survive cooking or other processes. A hospital kitchen in Santiago, Chile.

Photo WHO/P. Almasy
Health manpower is the key to the whole health system structure, as this system depends mainly on service delivery. Since the key person in health care delivery has traditionally been the physician, physicians have dominated the health manpower picture and have tried to build the pattern of health care around themselves. The result has sometimes been very far removed from the actual health needs of communities.

There have been other serious consequences. Firstly, a great deal of emphasis has been put on training and developing physicians, and very little attention has been paid to other categories of health personnel. The training of medical personnel has always been hospital-centred, and hospital-oriented health care has tended towards specialisation and sub-specialisation. As a result, community physicians and general practitioners have become "second class doctors" (the specialists being the "first class doctors"), and team work by all medical personnel has not been recognised as lying at the core of health care delivery. Finally, physicians have been left to themselves to plan the health care delivery system without involving such people as economists, paramedics, statisticians, planners and sociologists, while the medical schools have been dominated by physicians and shaped around them to the exclusion of other categories of health manpower.

These consequences have led to the over-production of certain manpower in some countries, especially the developed nations. And the surplus of physicians has become critical in developing and developed countries alike. On the other hand, a lack of other types of health manpower can be found in some countries such as Brazil, where physicians have even been doing the work of the nursing staff in certain areas of health care delivery.

Such situations do not only create an imbalance in manpower production, but also result in social unease and self-dissatisfaction. Thus in Mexico, the large numbers of unemployed physicians are causing a problem for the government, as they are very vocal in their demands and grievances because of their sophisticated education. In addition to this, the high cost of training of physicians poses a challenge to many governments in the present period of economic recession.

If the picture is already dark in some developed countries, the developing countries should learn their lesson and be fully aware of the great danger that may befall their own health care systems if proper thinking has not been applied to the issue of health manpower development.

What can they do? The answer is to undertake appropriate health manpower planning. How can this be done? Firstly they must establish the country’s health care delivery requirements, taking into consideration all the factors that influence economic and social conditions. Of course, health care delivery systems vary but if the guiding principle is the Alma-Ata Declaration on primary health care and the main goal is Health for all by the year 2000, the range of needs can easily be defined.

Next, they have to set down the proper objectives and goals in such a way that they can be quantifiably defined and easily accepted by the policy makers. They should move to create a central health planning body working in close coordination with the country’s general plan, if there is one. The central planning body should include representatives of all levels of health personnel, besides specialists from other fields such as economists, sociologists, statisticians, planners, health managers and education experts. And let us not forget the consumers—representatives from the general public.

It is important that the health plan produced by this central planning body should be built around the health needs of the population.
and should be realistic in its objectives and goals. A health plan document is easier to prepare than to carry out.

Now the problem will be to develop the right health manpower mix. This mix is the real fuel and moving force in carrying out and expanding health care, so the health manpower training system has to be carefully designed. This is where the real challenge for health planners exists. An appropriate coordination mechanism between the production of health manpower and the use made of that manpower is of utmost importance.

Finally, it is vital to clarify the role of ministries involved in health care delivery and the role of training bodies involved in health manpower production; proper links and coordination between these two bodies will require the utmost political backing. Without such backing the problems raised by an improper health manpower mix will seriously jeopardise the future of the developing countries.

Using the surplus

In view of the above, the question might be asked: How can we deploy a surplus of health manpower in developed countries to benefit the developing ones?

Much of this abundance of health manpower may on the face of it be unsuitable to the needs of the developing countries. But if it is truly intended to make use of this surplus, I believe that a real commitment should be made by the countries with a surplus to transfer these health personnel to developing countries once they have been properly trained and reoriented. The developing countries themselves should be willing to incorporate this influx of manpower into their health system after making sure that they are properly trained for the type of health care they will undertake. This programme could be carried out under the sponsorship of international organizations.

Who itself has a great deal of influence and prestige among all countries as regards the delivery of health care to counter the health problems of the world. But unfortunately, its role in health manpower development has not been effective and influential. This is in part due to the lack of coordination with other international organizations involved in manpower development globally, such as UNESCO, the UN Educational, Scientific and Cultural Organization.

Greater coordination and cooperation between these two organizations to achieve a better and more effective system for health manpower development will remain a challenge that has to be met. If WHO and UNESCO can accept such a challenge and attempt to develop better models for health care delivery systems and health manpower development, the benefits for developing countries can be of immense value.
**Setting the Record Straight About 'Monster Bugs'**

A charge made during a recent meeting of the Chicago chapter of the American Association for the Advancement of Science that "strains of monster bugs" resulted from use of DDT during malaria campaigns has been rebutted by WHO.

Where resistance to insecticides developed "this was mainly due to their widespread use in agriculture—in areas where there was intensive agricultural exploitation, involving aerial spraying of crops—and not to the limited amount used in malaria control operations," says Dr Hans Hellberg, until recently Director of WHO's Division of Public Information and Education for Health.

Who launched a worldwide malaria eradication programme in the mid-1950s on the basis of successes achieved in Europe, the southern United States, and areas of a number of tropical countries.

By 1966 the number of people living in areas free of malaria increased from an estimated 316 million to 997 million, and mortality declined from 2.5 million to under one million yearly. In India alone, the death rate dropped from 76,000 to 16,000—probably the single most significant indication of the programme's success.

"Hopes were high that malaria could be conquered before resistance appeared," Dr Hellberg says, "hopes which, with hindsight, are easy to criticise."

The criticism of WHO's malaria programme led to a story in the International Herald Tribune headed, "Misuse of Insecticides Creating Monster Bugs." In a reference to a statement that WHO had "given up" the programme in 1976, Dr Hellberg said:

"Who has not abandoned its malaria programme but its approach has changed. Who supports a three-pronged approach: the judicious use of suitable insecticides, biological control of disease-carrying insects, and general improvement of the environment."

It also supports research to find "new and better insecticides and drugs, as well as a malaria vaccine."

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**Biotechnology Era Of Vaccines Seen By Year 2000**

A new era of vaccines based on advances in biotechnological techniques will be ushered in by the Year 2000, predicts a group of leading scientists who met recently in Geneva to assess developments under the theme "Immunization: New Horizons."

So much progress has been made says Dr Kenneth S. Warren, Director of Health Sciences, Rockefeller Foundation, that these vaccines are likely to render antibiotics obsolete.

"It is my belief," he adds "that oral rehydration—that remarkable and relatively new tool for the treatment of diarrhoeal diseases—will be rarely used at the turn of the century. Even family planning will be aided by vaccines."

Among prospects are two vaccines against malaria, one genetically engineered, and the other synthetic, as a result of work in Australia and Sweden, which are "about to undergo their first testing in man": as well as vaccines against schistosomiasis, or small fever; against leprosy, now being tested in Venezuela; and against AIDS.

Although hepatitis B vaccines, based on techniques of genetic engineering, are being produced by "at least seven different manufacturers," he says, "a cheaper technique for producing the vaccine from plasma has been developed by the New York Blood Center. It is being made in Korea at a cost of approximately $1 a dose."

According to another participant, Dr Ralph Henderson, Director of WHO's Expanded Programme on Immunization: "Progress in biotechnology makes certain we will get improved vaccines for six children's diseases—measles, tetanus, whooping cough, polio, diphtheria, and tuberculosis.\" "We may say that 'we would certainly welcome vaccines that cause fewer side effects, that are less sensitive to heat, and that can be used with only one dose, and be given any time from birth,'" the task today, he wanted, "is to immunize with the "old" vaccines and thus protect children. "We need to complete this task without delay," he states, "for each day that passes condemns more than 9,000 children to needless death."

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**Smoke-Free Work Sites Growing World-wide**

The impetus to ban, or to curb, smoking at work sites and public places, is picking up momentum—in the United States particularly, but elsewhere as well. Among recent developments:

- **United States.** The Federal Government, the employer of 2.3 million people, has ordered all departments to provide a "reasonably smoke-free environment" on the job, in essence decreeing that smoking is now forbidden everywhere except where it is expressly permitted.

- **New York State has passed laws—considered the toughest in the country—against public smoking in such places as "indoor arenas, schools and auditoriums, club houses and court houses, gymnasiums, health clubs, rest rooms, stores, banks, hospitals and movie theatres," according to the New York Times. In banning smoking, the prestigious Mayo Clinic in Rochester, Minnesota has told its 14,000 workers that "to permit smoking would be inconsistent with our leadership role in health."

- **And, at a new community hospital opened recently in Wentzville, Missouri, smokers need not apply for employment, the management said.**

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**At WHO headquarters: A sign of changing times.**

Photo WHO/Tiber Farkas

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**RESPIRE A FOND ON NE FORMO PLUS**

BREATHE DEEPLY NO MORE SMOKING

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**WORLD HEALTH, Aug./Sept. 1987**

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WHO Found IUDs ‘Safe, Effective, And Reliable’

Intrauterine devices are “safe, effective and reliable” as a method of contraception, according to a group of experts from 13 countries. Meeting recently under the auspices of WHO to evaluate that method of contraception, they add, however, that “careful patient selection is essential for IUD use.”

IUDs: The choice of 60 million women.

Developed about three decades ago, IUDs are estimated today to be the choice of contraception for over 60 million women throughout the world. However, lawsuits have been taken out against manufacturers, notably in the United States because IUD use has been linked to an increased risk of pelvic inflammatory disease, and to infertility.

Two manufacturers have, as a result, discontinued production of IUDs, which in turn has “triggered off a worldwide chain reaction of complaints”, the experts say.

However, “the risk of pelvic inflammatory diseases from IUD use is much lower than that previously thought”, and “is over-estimated,” and “is apparently limited to the first four months after the insertion of the device,” they add.

While noting “with regret”, the withdrawal of the Lippes Loop, Copper 7, and Copper T 200—despite approval of use by the US Food and Drug Administration—from the US market, the experts point out that new copper devices—such as TCu220C, TCu380A Ag, and Nova T—are proving to be significantly better in preventing pregnancy than the earlier copper devices.

In addition, “the effective life of the new copper devices is at least five years, and thus they can be safely left in place,” they state.

Newsbriefs

・AIDS and a Smallpox Connection. Following a story carried in the Times of London stating that “the AIDS epidemic may have been triggered by the mass vaccination campaign which eradicated smallpox,” this response from Dr Jonathan Mann, Director of WHO’s programme on AIDS:

“The only result we know of from the smallpox eradication programme was the eradication of smallpox itself...

“In Asia, where hundreds of millions of smallpox vaccinations were given from 1967 to 1972, AIDS remains rare. Conversely, the United States is experiencing a major AIDS epidemic, yet smallpox was eradicated there many years ago (in the early 1950s).

“As many doses of smallpox vaccine were given in west Africa as in central Africa, yet AIDS is less common in west than in central Africa.”

・Calendar. Of more than usual noteworthiness, the 6th World Conference on Smoking and Health, from 9 to 12 November in Tokyo.

Among items on the agenda: smoking and women, smoking and children, passive smoking, and the economics of smoking.

The Japan Heart Foundation, the Japan Anti-Tuberculosis Association, the Japan Cancer Society, and the Japan Health Promotion and Fitness Foundation are represented on the conference’s organizing committee.

(For more information, write: Japan Convention Services, Inc., Nippon Press Center Bldg., 2-9-1 Uchikawacho, Chiyoda-ku, Tokyo 100.)

・“Inequity—a Sin”. This excerpt from an address by Dr Halldor Mahler, WHO’s Director-General, delivered at the 1st International Conference on the Ethical and Moral Problems of Pharmacotherapy held at the Vatican City:

“The gap between ‘health haves’ and ‘health have-nots’ can be summed up in one word—inequity. Need I remind you that the world at large will not help. Action is required.”

・Invitations to Research. Who is seeking proposals for research in these two areas of human reproduction: (1) the regulation of male fertility, and (2) the natural regulation of fertility. Being offered for the former are initial grants up to $10,000, and for the latter, up to $20,000.

Submissions, including a provisional budget, should be a page in length and sent to WHO’s Special Programme of Research, Development and Research Training in Human Reproduction, Geneva.

・Like Father, Not Like Son. An heir to the fortune that tobacco built has divested himself of all stock in the family business while calling for a smoke-free US society by the Year 2000.

“When my grandfather began manufacturing cigarettes at the turn of the century, he did not know that smoking causes lung disease, heart disease and cancer,” Patrick Reynolds told an interviewer from the New York Times. “Now that this has been absolutely proven, I want to help people wake up to how poisonous cigarettes are.”

Ironically, R.J. Reynolds, Sr., founder of the tobacco company that bears his name, shunned cigarettes—“He sold them, but would not smoke them,” his grandson says—but his son, R.J. Reynolds, Jr., was a heavy smoker who developed emphysema, and died at age 58.

Grandson Patrick quit after years of struggle. “It was a real battle, and I know hard it is to stop,” he says of the habit picked up as an unsuspecting teenager.

In the next issue

The October issue of World Health will be devoted to different aspects of the work of WHO and its collaborators in the health field throughout North, Central and South America—the Region of the Americas.
Preventing a smallpox "demon" from landing in Japan. See page 31.