OHE briefing

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IMMUNISATION FOR EVERYONE – THE POLIO EXAMPLE

In the richer nations of Europe and North America the gaining of control over the common infectious illnesses was a long, gradual process. It was initiated by improvements in the diet available to the mass of the people, coupled with public health measures like the provision of clean water supplies and adequate sanitation. Subsequently the attack was driven home by advances in both curative and preventive medicine. Amongst the most significant of these were the development of effective and safe immunising techniques. There are today around 80 vaccines which protect against a wide range of infectious diseases.

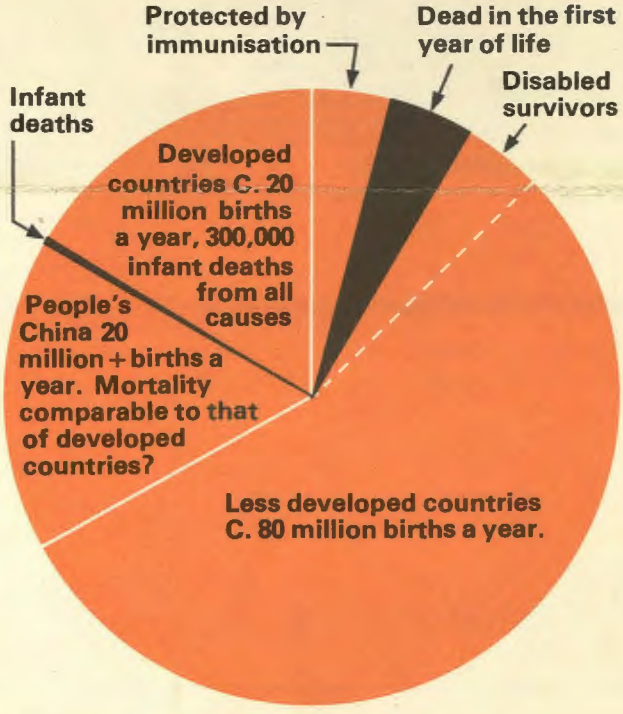
In countries like Britain it is taken for granted that the availability of modern medical techniques guarantees that the average person will not be affected by the killers which haunted Victorian families such as diphtheria, whooping cough, tetanus and tuberculosis. For wealthier sections of the less developed nations this is also so. And in the People's Republic of China, with its unique cultural, economic and medical systems, the advances of the last 30 years have similarly brought a high degree of 'biological security' to the bulk of the population.

However, in much of Africa, Asia and Latin America, where around four fifths of the population are rural peasants, people do not have ready access to the relatively cheap, simple, and well tried techniques of immunisation which could help to improve their quality and expectation of life. Figure 1, based on WHO/OHE estimates, indicates that out of the 80 million children born in less developed countries other than China each year around 75 million are not vaccinated even against diseases like polio, TB or measles.

Some commentators are pessimistic about the possibilities for extending protection against everyday disease to the bulk of the world's children. A few may even believe that improved survival rates could aggravate the problems created by rapid population increases, though the weight of evidence shows that for birth control techniques to be freely accepted potential parents need to be reasonably certain about the survival chances of the reduced number of children they decide to have. At present each year around 5 million of the world's children die in their first twelve months of life from six ubiquitous diseases which could be controlled by vaccination – tuberculosis, measles, whooping cough, tetanus, diphtheria and polio (WHO 1979). (See Table 1) A similar number live on but with physical or mental impairments. For all children under 15 the annual death toll from these diseases is probably over 12 million.

However, formidable as the size of this problem is, the successful eradication of smallpox by the recent WHO programme (originally proposed by the Soviet Union in the 1950s and intensified in 1967) has led many authorities to believe that worldwide control of these six major

Figure 1 *The World's Children – deaths in the first year of life from the six EPI target diseases*



Estimated total births 120 million per annum

Source: WHO/OHE Estimates.

childhood causes of death and disability is a realistic goal. Accordingly the WHO in 1974 launched its Extended Programme on Immunisation (EPI), the objective of which is to give basic protection to all children by the 1990s.

The purpose of this *OHE briefing* is to highlight key medical, social and economic aspects of the EPI with special reference to polio control. The severe, potentially handicapping effects of this condition, the fact that without immunisation it is likely to become a greater problem in the future and the availability of oral vaccines make it an important example. In addition, new initiatives by voluntary organisations planned in conjunction with EPI controllers and aimed at reducing the impact of conditions like polio in poorer nations raise topical issues relevant to the financing of extended immunisation.

Controlling polio in the developed countries

Figure 2 traces (on a semi-log scale) the number of cases of acute paralytic poliomyelitis recorded in England and Wales since it first came a notifiable disease in 1912. It shows clearly the dramatic rise in the incidence of the condition after World War II and the even more spectacular reduction after the introduction of vaccination in the late 1950s.

A similar general pattern is displayed in Figure 3, which describes Swedish experience in the period 1905-1970 (on a non log scale). The only significant difference in trend appears to be that the Swedish recorded incidence for polio was much higher than that of England at around the start of the first World War. This was in part because polio was under-reported in the early years of the British notification scheme (there is evidence from an OHE disability survey of an epidemic matching that in Sweden – OHE 1965) but it could also be because Sweden was the first nation to suffer major polio epidemics. The initial one was in the northern town of Umea in 1881. Another followed in Stockholm in 1887 (OHE 1963). The epidemic of 1905 was the first to be fully recorded.

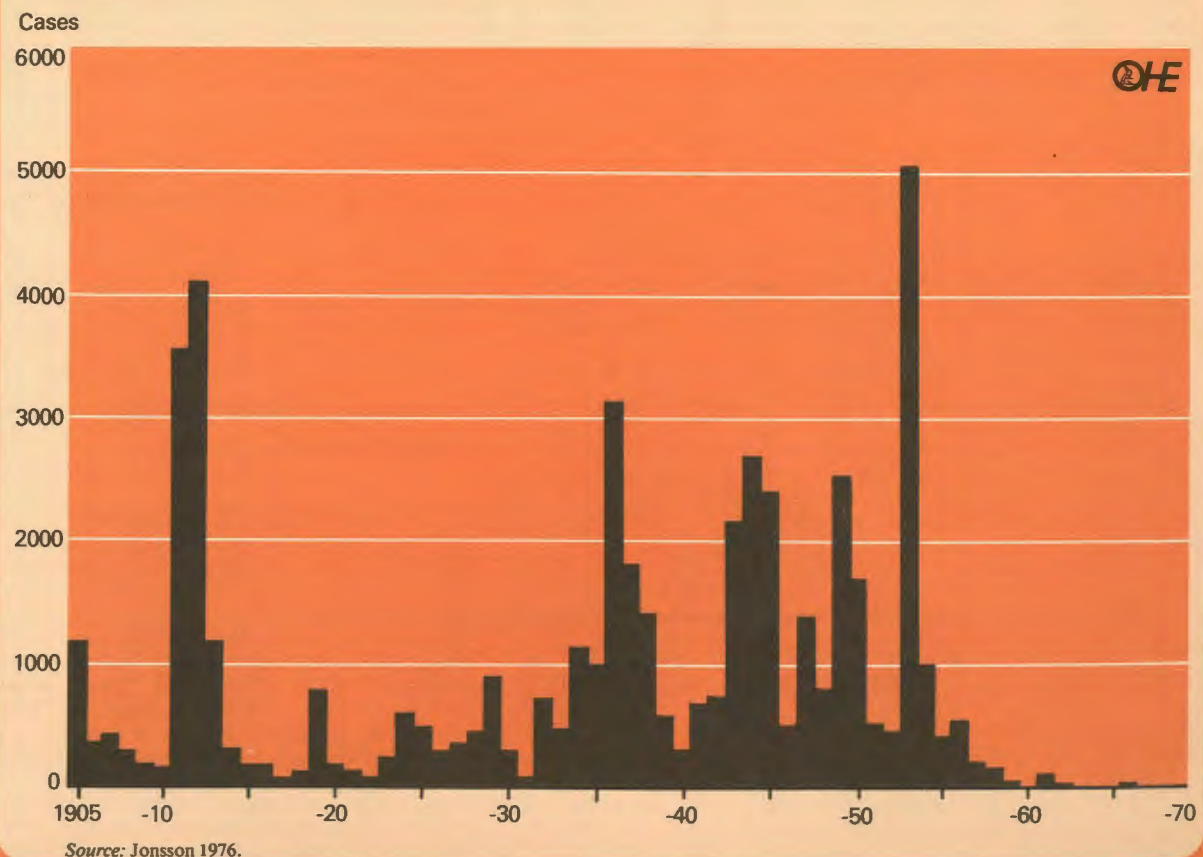
The reason for Sweden's early experience of epidemic polio is related to the fact that the three types of the virus responsible for the disease (and which can cause paralysis by destroying parts of the victim's nervous system) are most likely to have serious effects in older children and adults. The polio virus is spread by the oral-faecal route. This means that in poor societies with inadequate sanitation and many vectors such as flies the disease is endemic and nearly everyone is infected at an early age. Although up to one per cent of the total population in such circumstances may be to a degree impaired as a result of polio, severe disablement is relatively rare. Also because cases may appear quite uniformly across the country they may tend to pass unnoticed, melting in with 'normal' background levels of mortality and morbidity.[1]

1 In fact polio impairments, characterised by the withering and distortion of a limb or limbs after the destruction of nervous tissue, are known to have occurred in Egypt before 1000 B.C. The first clinical description of the disease was given by the London physician Michael Underwood in 1789. Nevertheless it is still sometimes incorrectly thought of as a condition confined to 'developed' nations in the twentieth century.

Figure 2 *Poliomyelitis in England and Wales 1912-79*

Note: Semi Log scale *Source:* Registrar-General and PHLS.

Figure 3 *Acute Poliomyelitis in Sweden 1905-1970*



Source: Jonsson 1976.

Table 1 *The six EPI target diseases*

DIPHTHERIA
Active immunisation with diphtheria toxoid is the only effective means of control. The case fatality rate varies between 10 per cent and 20 per cent. The disease affects the tonsils, larynx, pharynx and or nose and threatens life through the formation of a suffocating membrane. In pre-war Britain it caused about 3,000 deaths a year. But with the introduction of a full scale immunisation programme in the early 1940s the condition was virtually eradicated by 1960.

MEASLES
A highly infectious condition, measles kills about 10 per cent of those who catch it in the poorer, malnourished areas of the 'third world'. Survivors may suffer damage to their lungs, brain and/or their eyes. Live vaccine gives over 95 per cent protection for a prolonged period.

POLIO
Polio impairs around 500,000 children in less developed countries each year. Many have only minor disabilities, especially if they live in poor sanitary conditions and have contracted it in the first two or three years of life. But as hygiene standards improve the proportion severely impaired rises with the mean age of onset. Child deaths amount to only about 1 per cent of the total burden imposed by the 6 target diseases, but if immunisation is not extended this proportion will rise in years to come.

TETANUS
'Lockjaw' was first described by Hippocrates some 500 years before the birth of Christ. The fatality rate is around 70 per cent and it accounts for around 1 in 10 of deaths of newborn children in the rural 'third world'. Infection often occurs via the unhealed umbilicus.

TUBERCULOSIS
In all there are about 15 million active cases in less developed countries. Only a limited proportion are in the child population, but amongst them it can cause a distressing and unpleasant death. Experience in countries like the Philippines and Indonesia shows that BCG vaccination can largely control the condition even amongst populations living in poor conditions, although medicines may also be needed to limit morbidity. Ideally better living standards will help one day to cut its transmission.

WHOOPING COUGH
Pertussis kills or disables hundreds of thousands of 'poor-world' children each year. Four fifths of the mortality occurs in the first year of life. Survivors may suffer lung or brain damage. Vaccines may have unwanted effects in a tiny proportion of cases but there can be no doubt as to their overwhelming value in LDCs. In richer countries like Britain the scientific evidence is still on the side of continuing protection, although critical (and sometimes misleading) comments have undermined public confidence in immunisation.

But as societies grow richer sanitation and general hygiene tend to improve. In the special case of early to middle twentieth century Europe and North America the number of insect vectors was also cut by the replacement of horses by mechanical vehicles and changes in the pattern and techniques of agriculture. Hence the circulation of the virus was reduced. Fewer people became infected, and those cases that did occur were relatively late in life. The disease hence became epidemic rather than endemic and the proportion of cases involving severe impairment rose. Polio's visibility, if not its true overall impact, was increased.

Aspects of this cycle were clearly illustrated in Britain in the period immediately after World War II. Awareness of the disease was raised during the war because young soldiers frequently encountered the virus for the first time in countries like Egypt, Malta and Italy.[2] The recorded incidence of paralytic poliomyelitis amongst them ranged between 2 and 5 per 1000.

When the war ended returning soldiers may have brought back wild virus with them, as well as doctors more capable of recognising polio and the impairments it generates. The notification rate rose steeply from its previous level. It is estimated that during the period 1947-58 polio caused over 5,000 cases of severe permanent disablement.

In the order of 32,000 people overall had some residual paralysis whilst there were some 3,000 deaths (OHE 1963). Two thirds of the victims were children. Public concern rose with the recorded incidence rate, partly because at that time other infectious paediatric illnesses were finally being well controlled. Parents were learning to expect, as of right, a healthy, disability free childhood for their offspring.

In response to the resultant pressures academic and industrial research was intensified and, following the successful culturing of polio virus by Enders in 1949, a killed (inactivated) vaccine was developed by Salk and his colleagues in 1954. The early stages of the vaccination programme which started in the United States in 1955 were marred by the Cutter Incident in which undetected, live, virulent virus in the supposedly killed vaccine tragically caused a number of cases. But since then inactivated vaccines which are unquestionably safe and effective have been produced. Their disadvantages are that like other vaccines they need to be injected and also that perhaps four or five doses are needed to maintain lifetime immunity.

In 1957 a live virus vaccine – the Sabin vaccine – was developed. After initial use in the Congo and Singapore it was tried on a large scale in the Soviet Union in 1959. It became the routine method of vaccination in Britain in 1962. The advantage of the live vaccine is that because polio is an entero-virus which multiplies in the gut it can be given by mouth. Subsequently the mild virus strains may be passed to other non-vaccinated people by the usual infective route and so the immunity of the population as a whole against wild, virulent virus, is increased. But against this some people may suffer a paralytic attack on exposure to the vaccine strains. In children this hazard is probably only about 1 in 5 million (Collingham et al 1978) but in adults who are immunised it may be nearer 1 in 100,000 (Pollock 1979a).

Current policy issues in Britain

At first sight the problem of polio in Britain appears to be more or less resolved. However, detailed analysis shows that even with regard to the control of this now rare disease there are a number of potentially important decisions still to be made. The danger of fresh outbreaks of the condition is still real. This fact was emphasised by experience in Holland in 1978, where there were 108 reported cases amongst members of a religious group who had refused vaccination.

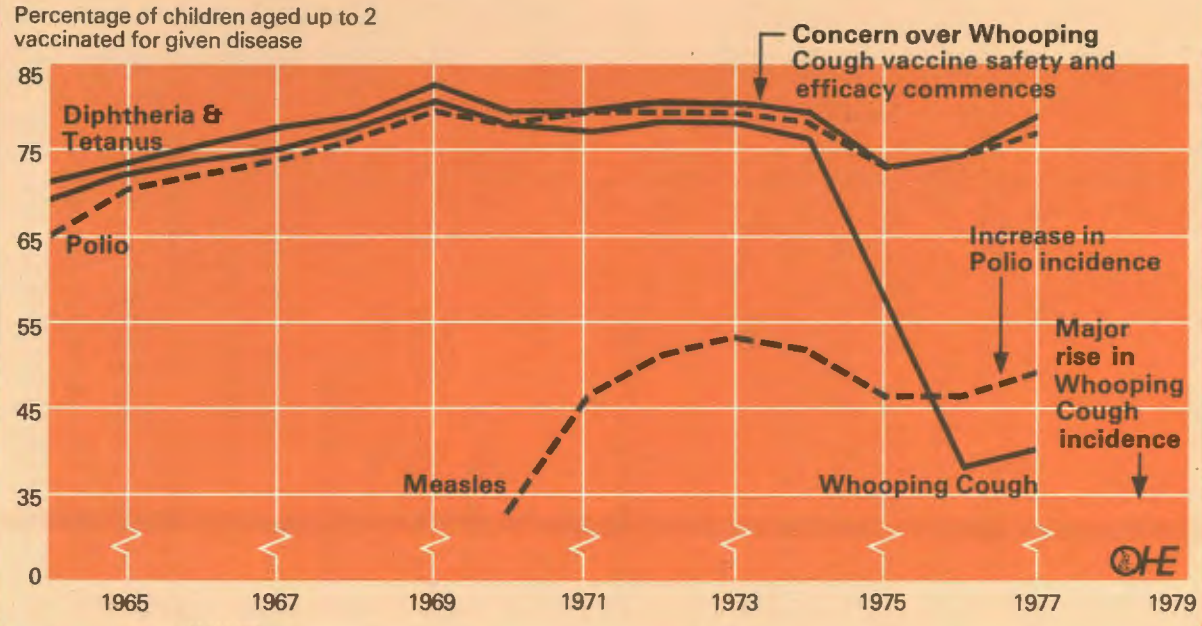
Figure 2 indicates that in 1976/77 there was a sudden increase in polio incidence in England and Wales. Of the 26 cases notified 6 were associated with immunisation but the remainder were the result of contact with wild virus. As Figure 4 shows this upturn followed a period in which the proportion of babies protected fell slightly, from around 80 per cent to about 74 per cent. In some localities, such as Rochdale, the proportion vaccinated was below 50 per cent (Collingham et al 1978). These data underline the need to maintain the child immunisation rate in the U.K. at an average level of at least 80 per cent and the desirability of attempts to ensure that all sub-groups of the population are protected. It is of note that 6 of the 1976/77 cases were amongst itinerant caravan dwellers.

Other points to emerge include the clear value of close epidemiological surveillance and of swift 'fire fighting' action to control sporadic outbreaks. Extensive use of live vaccine in such circumstances not only helps to increase immunity directly but it may also aid control in that the avirulent vaccine viruses will compete with, and hence retard the spread of, the wild strains. Indeed, it has been tentatively (though questionably) suggested that, if the Dutch authorities had used live instead of inactivated vaccine for their routine programme, spread of the attenuated strain might have protected the un-immunised members of their society, so preventing the 1978 epidemic.

But two riders must be added to this last observation. First, although the use of live vaccine may have the benefits outlined above it also carries the theoretical risk that at some point the circulating virus may regain virulent properties (although individual vaccine-associated cases may result from immunological abnormality). Eradication of the polio virus in given localities (as has been achieved in Sweden by the use of inactivated vaccine) cannot be achieved by live vaccine. Second, the prevalence of polio virus world wide means that even if high immunisation levels are maintained in the U.K. there is

2 The relatively late development of Southern Italy meant that polio was a major problem until quite recently. The number of cases reported in 1951-55 in Italy was 3,342 per annum. In 1961-65 it was 2,121. In 1976 it was 9.

Figure 4 *Children vaccinated by the end of their second year of life. England 1964-1977*



Source: Hansard 21/11/78.

always a high risk of wild virus importation from abroad by travellers.[3] How long live vaccine maintains adequate immunity is uncertain. Circulating antibody levels may drop even though 'gut-immunity' remains. This might mean that some people immunised with live vaccine in childhood will in later life become vulnerable to wild virus attack, even though residual 'gut-immunity' can prevent booster doses of live vaccine 'taking' and so being effective (Smith et al 1976).

The extent that this possibility is becoming a practical reality is as yet unknown. But it could be that although the use of live vaccine for children and adults who are either non-immune or who in the past were given a killed vaccine is likely to remain the most desirable policy for the U.K. there will eventually be a need to introduce an adult 'booster' programme using inactivated vaccine (Pollock 1979b).

Polio in the less developed countries

The direct interest of the rich nations in helping to control infectious illnesses in the less advantaged parts of the world stems in part from the desire to reduce the risk of importing disease via travellers and also to cut the cost of preventing such hazards. It is estimated, for example, that the industrialised nations stand to gain around £500 million per annum from the relaxation of the need to guard against smallpox. This is more than the entire cost of the eradication programme in the period 1967-80, some two thirds of which has been paid for by the poorer nations themselves.

Also there are questions relating to the acceptability of birth control and the need to reduce disease incidence. Polio is especially important here because it is likely to grow more visible, if not more prevalent, as environmental standards improve. Unless it is tackled before, or at least whilst, adequate sanitation systems and clean water supplies are being established the onset of polio epidemics could shake public confidence in health workers and family planning advisers from the 'developed' countries.

In this context Figure 5, which may be termed a traditional epidemiological view of poliomyelitis incidence, is of interest in that it appears to show that before the introduction of vaccination there was a close association between national development and the impact of the disease. In reality this is a phenomenon which, as noted above, is mainly related to reporting variations and the shift from endemicity to epidemic occurrence. But the implications of the Figure usefully illustrate the urgent need to control polio at this stage of 'third world' progress, quite apart from the absolute level of human suffering and disabilities which could be saved by appropriate action.

Regarding this last area, that of humanitarian concern, current WHO figures indicate that the reported polio incidence rate in countries participating in the EPI is about 50 times higher than that in Europe and North America. But even these data are unreliable. WHO statistics probably understate the impact of polio in the poorer countries of Africa, Asia and Latin America by a factor of between 20 and 30 times, according to recent surveys in Malawi and Thailand (Ward 1979). Allowing for mortality and the proportion of cases which recover the best available figures indicate that there may be up to 8 million 'third world' children suffering permanent physical impairments as a result of polio, although few are likely to be officially recognised as polio victims. Over half a million are likely to be severely disabled.

Extending immunisation

The scale and nature of polio inflicted hardships make it easy to understand why the WHO has made the condition one of the six targets of the EPI and why the Save the Children Fund (SCF) has recently decided to focus a major contribution to the latter on polio immunisation.[4] The main requirements for an effective and appropriate programme may be grouped under the seven main topic heads shown in Table 2.

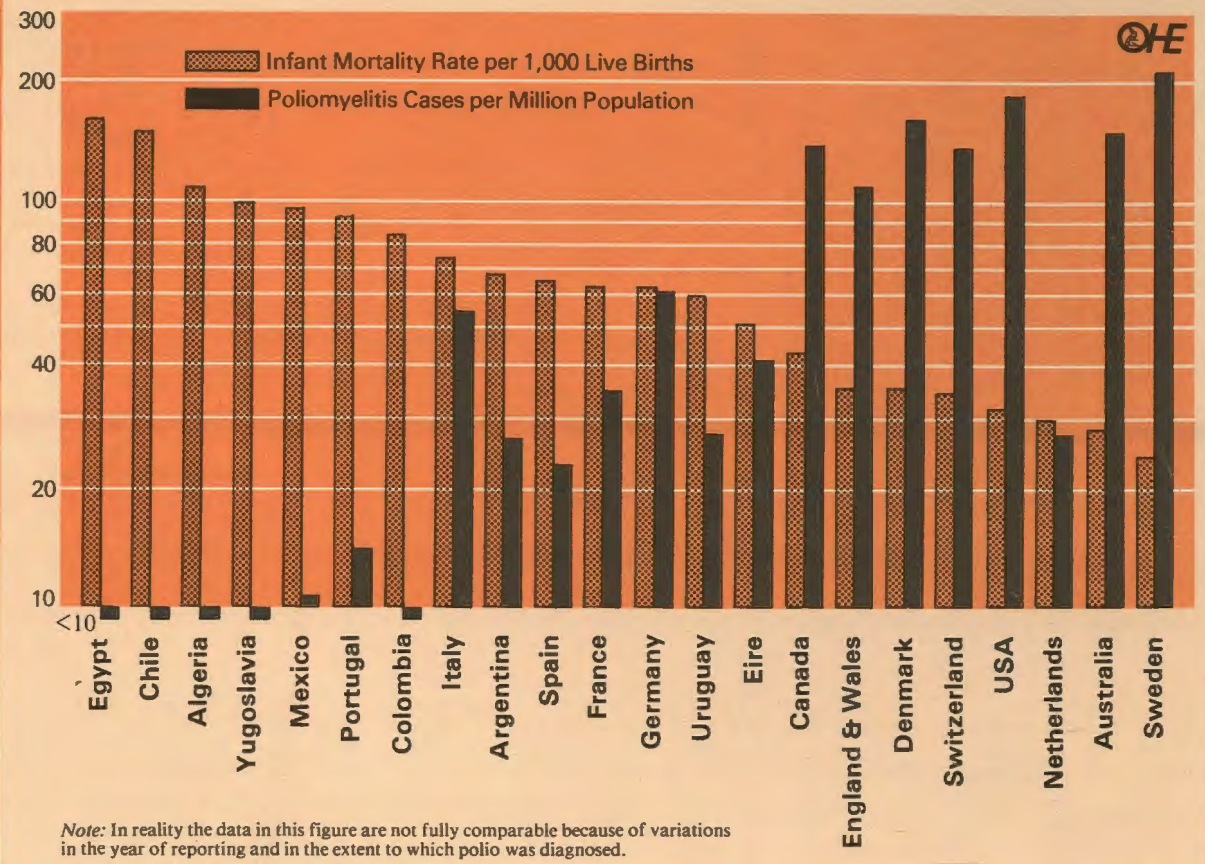
There are no insurmountable technological barriers in any of the areas listed. The primary challenges are on the political, managerial and economic levels, although improvements in the heat stability of vaccines and/or the methods of maintaining an efficient 'cold chain' from store to field delivery would be very valuable.[5] It is, for instance, necessary to keep live polio vaccine in long term store at —20°C and to ensure that its temperature does not rise above about 4°C before use. In hot, poor countries the energy costs of doing so are high and equipment or power failures often mean that vaccine potency is lost. U.K. agencies involved in work in this field include the University of Strathclyde's Centre for Industrial Innovation and scientists at the Atomic Energy Authority's establishment at Harwell. Currently a number of improved 'cold box' designs and hardy, multi-fuel ice makers and refrigerators are on trial.

3 It has been observed that in some areas of the U.K. only about half of all adults are immune to all three polio strains (Codd and White 1977).

4 The pilot programmes of the SCF campaign are to be in Malawi, Lesotho and Swaziland. The SCF, which celebrates its 60th anniversary this year, intends to analyse its experience in these three areas and then to expand its efforts as financial support allows.

5 Academic and pharmaceutical industry researchers are involved in attempts to reduce vaccine heat lability in a number of fields. For example, a more stable measles vaccine has recently been used in field conditions in the Cameroon (Heyman et al 1979). In the past the development of heat-stable freeze dried smallpox and tuberculosis vaccines increased the viability of immunisation programmes for these conditions.

Figure 5 *Poliomyelitis and economic development before vaccination - the view in the mid 1950s*



Note: In reality the data in this figure are not fully comparable because of variations in the year of reporting and in the extent to which polio was diagnosed.

Source: SCF Briefing document.

The experience gained by the WHO during the smallpox eradication programme has given its personnel valuable knowledge about how to motivate health workers and encourage public support for and participation in immunisation extension even though there may be initial barriers of ignorance, apathy and superstitious rejection. Despite the magnitude of the problems facing the organisation there appears theoretically at least every reason to believe that its methodical approach will be able to help co-operating countries to establish efficient, permanent arrangements for vaccine delivery to at least the great majority of their child populations by 1990. Unlike smallpox eradication, which was a 'once off' effort,[6] EPI could thus help provide poorer countries with health infrastructures capable of swiftly extending future technical advances to their people. The arrangements established to control diseases like polio and measles in the 1980s may one day be instrumental in attacking conditions like leprosy, schistosomiasis and malaria by immunological methods.

Economic barriers to EPI success?

There are a number of factors which may restrain, temporarily at least, progress towards establishing adequate immunisation/primary care services world wide. One relates to the availability and training of suitable staff at all levels and retaining them once they have become experienced.

Another relates to vaccine availability. Some short term limitations are naturally to be expected but social and political pressures in the 'developed' countries, especially America, may in the future lead to more serious long term problems unless held in check. The combination in rich societies of unbridled price competition coupled with very extensive statutory safety regulations and laws which make companies liable to pay high damages in cases of unwanted (and often unavoidable) side effects is tending to make vaccine manufacture unattractive in the Western world. The consequences of the resultant capacity reductions are most likely to be directly experienced in third world markets, even though nations like the Soviet Union have substantial (and less impeded) production capabilities and larger developing countries may in time be able to build up economically sound domestic manufacturing plants.

Nevertheless, supply difficulties should be avoidable, particularly if vaccine prices are allowed to rise to realistic

Table 2 *Key requirements for immunisation programmes in less developed countries*

1 An effective vaccine, the potency of which can be and is tested at all stages from its manufacture to delivery in the field.

2 An established 'cold chain', down which the vaccine is transported. In a given developing country this may start with a central deep-freeze and work down via refrigerated vehicles or large cold-boxes to small vessels capable of being carried by health personnel.

3 A permanent delivery to child system, perhaps based on fixed clinics and/or an extensive mother and child health care service (as in Malaysia). Monitoring and supervising capacity is essential at every stage of the organisation.

4 A mobile supervisory force.

5 A disease surveillance system capable of detecting new outbreaks of target diseases and determining their reason, whether this be vaccine failure or insufficient uptake of protection. Overall monitoring of vaccination rates is thus a key role at this level.

6 A central administrative unit, capable of long term planning, budgetary control and cost-effectiveness analysis.

7 Research, documentation and staff training facilities.

6 With smallpox there was a conjunction of a highly effective vaccine and a virus with no non-human hosts, limited infectivity and very limited survival outside an infected person. Total eradication of other conditions may be much more difficult although as a long term goal it is in most instances feasible.

levels. The most likely barriers to EPI success are shortfalls in the finance available for overall vaccination programmes in individual developing countries. The total cost of protecting children from the six target diseases is likely to be only £1.50 or £2 per head. (The SCF provisionally cost their polio protection programme at 90p per capita, only 6p of which is for the purchase of European made vaccine[7]). Half of the total cost of EPI, which by the end of the 1980s will be about £150 million a year in today's prices, will probably have to be met by the less developed nations themselves rather than by international agencies or 'developed' world governments. Not all poor States will be able to provide the resources demanded, small though they are in Western terms.

To many people this may seem a surprising situation. Some may assume that governments in rich countries would automatically supply funds for such a clearly 'good cause'. Others, noting the large benefit to cost ratio which economists in countries like Britain and Sweden attribute to measures like polio vaccination (OHE 1963, Jonasson 1971, Lindholm 1973), may believe that authorities in poorer countries have so much to gain economically from immunisation that they would necessarily divert their scant funds towards such efforts.

In reality the situation is more complex. Rich nations' actions at a political level put the health needs of the poor world's children in the context of their own urgent economic priorities. In the less developed countries themselves, with high unemployment and limited health facilities, economic priorities differ from those of countries like Britain. Attempts by bodies like OHE to gauge the benefits of polio immunisation here, whether measured in terms of production saved or NHS expenditure avoided, are often predicated on the existence of a productive industrial infrastructure and an expensive health service open to all. In countries without such assets the economically intangible personal losses caused by premature death or long term disability may well be equivalent to those experienced by individuals in this country. But these are not phenomena which State planners or academic economists are in practice likely to deem of critical importance.

In the face of this fact the involvement of voluntary organisations in this stage of EPI development can be very important. In addition to the planned SCF initiative bodies like, for example, Rotary International and the Baptist church have already involved themselves in this field and the Council of World Organisations Interested in the Handicapped has established an EPI Liaison Committee (Guthrie 1979). Their efforts could do much to assist the WHO in its attempts to stimulate more government and public interest on behalf of the 75 million children born each year in areas without adequate immunisation services. In addition their fund raising skills will generate resources for pilot services. Indeed, provided the long term goal of permanent, co-ordinated primary health care services for the world's poor is kept clearly in sight the intervention of voluntary bodies and private individuals in this area seems not only desirable but necessary.

Conclusions

In the less developed nations it is possible that the use of sophisticated vaccines and medicines will pave the way for social and economic progress. Breaking the cycles of disease and disability could free their populations to construct a better environment and lead more secure lives. With the possible (if dubious) exception of smallpox control in the eighteenth century (Razzell 1965, Henderson 1976) this would be a complete reversal of the pattern experienced in much of the now economically developed world.

In the special case of poliomyelitis two points clearly emerge from analysis of today's opportunities for its control. First, modern technology can already provide an effective means of prevention at an affordable price. Even if services were established to deliver polio vaccine alone the total cost of protecting successive cohorts of all currently un-immunised 'third world' children would only be about £100 million per annum. That is rather less than the British public will spend on going to the cinema in 1979.

7 This figure may be below the cost of vaccine manufacture in many plants. Given problems like the need at present for development of new viral 'seed' strains there is a very real danger that attempts at short term economy by purchasing agencies will generate long term polio vaccine supply difficulties.

Second, when social developments cause a health problem, whether psychiatric or physical, the unthinking response of popular commentators is often to assume that the development itself is somehow undesirable. But in the case of epidemic polio causing high rates of severe impairment the 'cause' of its appearance is improved sanitation and hygiene. This is a clear example of an area where the best approach is not removal of the primary change but to use high technology and appropriate organisational arrangements to help populations adjust to new conditions (Jonsson 1976).

Hopefully, therefore, the fruits of past scientific research and industrial enterprise in countries like Britain and America will assist today's poor nations to change their ways of life and death more effectively and swiftly than would otherwise be possible. Yet despite the fact that most people would like to see the pall of disease and suffering which still spreads over most of the world's children lifted there is sometimes confusion as to how the resources needed to achieve this goal are likely to be provided.

Often well meaning individuals argue that rich nations should supply the extra funds needed to supplement the wealth of the less developed countries or that multinational companies should act as unofficial aid agencies, dispensing their skills and products freely to all those who clearly need but cannot afford them. But the same people often demand that their governments keep taxes to a minimum and ensure that the profits of pharmaceutical manufacturers in developed countries are kept to a relatively low level. In the presence of such potentially conflicting and confusing forces there can be little question that people who feel strongly that the objectives of initiatives like the WHO's Extended Programme on Immunisation are desirable would be well advised to attempt to participate directly in charitable efforts to ensure the availability of adequate funds world wide. In this respect 'third world' progress may well parallel that of eighteenth and nineteenth century Britain, where the private efforts of humane reformers frequently laid the foundations of services subsequently taken over by public authorities.

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