CHILDHOOD VACCINATION

current controversies

CHILDHOOD VACCINATION

current controversies

Office of Health Economics
12 Whitehall London SW1A 2DY

No 76 in a series of papers on current health problems published by the Office of Health Economics. Copies are available at £1.00
For previous papers see inside back cover.

ISSN 0473 8837

Cover illustration by courtesy of the Mary Evans Picture Library

This paper was researched and written by **Nicholas Wells**

OFFICE OF HEALTH ECONOMICS

The Office of Health Economics was founded in 1962 by the Association of the British Pharmaceutical Industry. Its terms of reference are:

To undertake research on the economic aspects of medical care.

To investigate other health and social problems.

To collect data from other countries.

To publish results, data and conclusions relevant to the above.

The Office of Health Economics welcomes financial support and discussions on research problems with any persons or bodies interested in its work.

INTRODUCTION

The historical roots of immunisation can probably be traced back to ancient Greek and Chinese civilisations and the observation that adults who survived an attack of smallpox did not usually contract the disease a second time. Yet the 'modern era' is perhaps generally regarded as having commenced at the end of the eighteenth century with Jenner's demonstration that smallpox could be prevented by first 'vaccinating' individuals with cowpox. Eighty years later, the work of Pasteur in France and Koch in Germany established the science of bacteriology, thus paving the way for the development of vaccines. The latter process has continued into the twentieth century and has been responsible for a number of remarkable successes in preventive medicine.

A dramatic example of the benefits generated by vaccination is evident in the context of diphtheria. During the 1930s an average of 61,000 cases of the disease were experienced each year in England and Wales, resulting in the deaths of approximately 3,000 individuals (Cockburn 1978). Throughout the same decade a safe and highly efficient immunising agent had in fact been available but it was not until 1942 that a national campaign was launched with the goal of protecting all diphtheria susceptible persons under 15 years of age.[1] The initiative had a rapid impact: within 10 years, the annual number of cases and fatalities had fallen to 376 and 23 respectively and by 1962 to 16 and 2. The most up-to-date information available indicates that during the first three years and nine months of the 1980s there were 15 notified cases of diphtheria and only one death.

Poliomyelitis provides further evidence of the potential benefits of an effective programme of immunisation. During the quinquennium preceding the introduction of a mass immunisation campaign in 1956, there were on average 2,827 notified cases of poliomyelitis and 326 deaths from the disease each year in England and Wales (Cockburn 1978). Extensive take-up of the vaccine – by September 1963, 19 million persons had received two doses – increasingly inhibited survival of the virus in the community, resulting in a 100 fold decrease in notifications between 1957 and 1963 (Griffith 1979). Subsequently a policy of routine immunisation for infants has been pursued and in the 1980s to date (that is to September 1983) only 10 cases of acute poliomyelitis have been notified to the authorities.

However, two other 'traditional' childhood infections – measles and whooping cough – remain sources of concern because of the

1 These individuals accounted for 90 per cent of all cases of the disease.

persistently high levels of ill-health with which they are associated. In 1982, nearly 66,000 cases of whooping cough and 94,000 cases of measles were notified to the health authorities in England and Wales. Effective vaccines are available for both of these diseases so that a substantial proportion of this morbidity may be regarded as unnecessary. Currently, however, only one child in two is protected against the illnesses.

Inadequate vaccination levels have also been put forward as one of the factors underlying the failure substantially to reduce the number of cases of congenital rubella syndrome. The upsurge in the incidence of rubella in 1978–79 led to at least 120 babies being born with defects because their mothers contracted the disease in the early stages of pregnancy. In addition, 1,405 pregnancies were legally terminated for rubella associated reasons (DHSS 1983). Against this background Smith (1983) has commented that 'immunisation of children against infectious diseases is one of the most obvious failures of the NHS'.

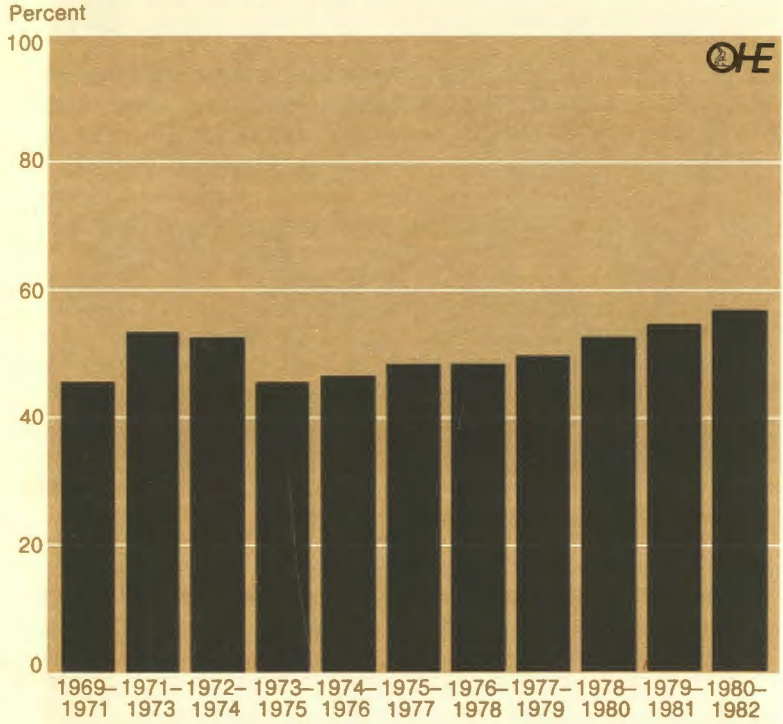
This paper investigates the purported deficiencies of vaccination policies in Britain as they relate to measles, rubella and whooping cough. The analyses it offers make clear that the scope for debate is extensive and prohibitive of straightforward solutions. Nevertheless, the paper draws a number of general conclusions which might point the way to future reductions in the volume of morbidity currently generated by these three diseases.

MEASLES

Measles is a highly contagious viral disease which is widely regarded as a relatively innocuous episode of ill-health and an almost inevitable experience of early childhood. Available evidence suggests, however, that this view of measles is inappropriate and that the disease can cause significant morbidity and mortality. From a follow-up study of nearly 9,000 cases of measles notified during the last quarter of 1976, Miller (1978) has reported that 4 per cent of episodes may be regarded as severe and a further 44 per cent as moderately severe. More detailed analysis indicated a death rate of approximately one per 5,000 cases and a complication rate of 10 per cent. The latter, usually either otitis media (46 per cent) or respiratory conditions (40 per cent)[2] were of sufficient severity to necessitate hospital admission in 1.4 per cent of cases. Furthermore, comparison of these results with those

2 Neurological sequelae occurred in 7 per 1,000 cases of measles and accounted for 6 per cent of observed complications. Two cases of encephalitis were reported from the sample, both following an apparently innocuous attack of measles.

Figure 1 **Measles vaccine: children born in first year and vaccinated by end of second year, Great Britain, percentages.**

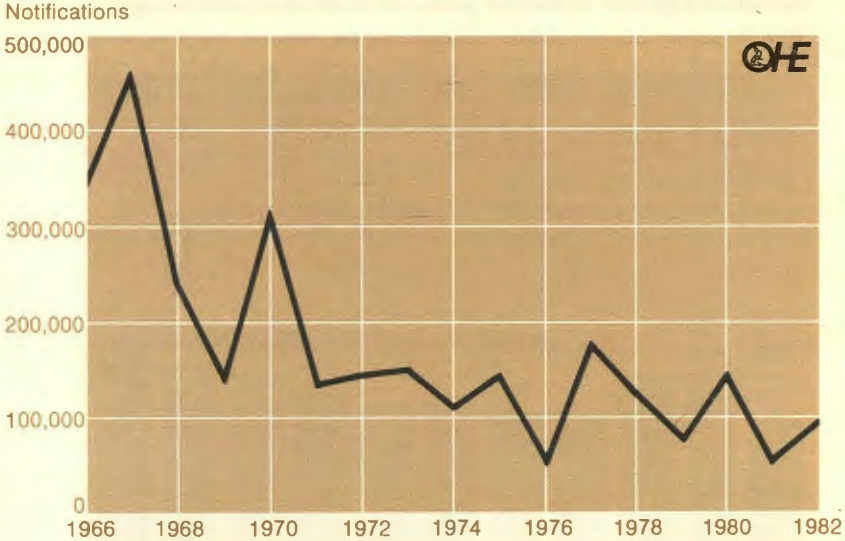


Source *Social Trends* No 14.

obtained by a previous survey of measles complications undertaken in 1963 (Miller 1964) yielded no evidence to suggest that the disease is becoming any less dangerous over time.

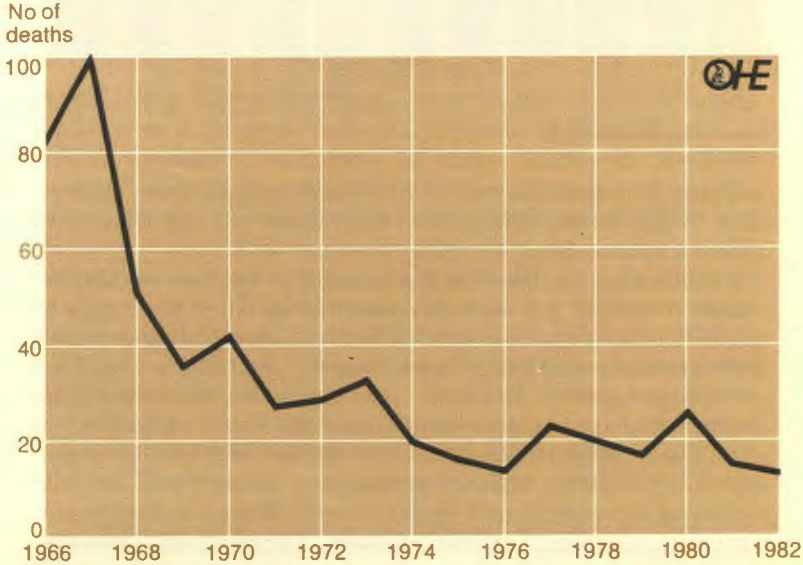
It is nevertheless clear that a substantial proportion of measles related morbidity and mortality could be avoided. Since 1968 a vaccine has been available which is both effective – administration at the recommended age of approximately 15 months provides 95 per cent protection – and safe – post-vaccination central nervous system complications occur about once for every million doses given (*Lancet* 1983). However, vaccine take-up rates have been disappointing. Figure 1 shows that despite a recent trend towards increasing acceptance, only 56 per cent of children in Britain are currently vaccinated against measles. Consequently, measles epidemics have continued to occur and notifications have yet to

Figure 2 **Notifications of measles in England and Wales, 1966–82.**



Source Communicable Disease Statistics.

Figure 3 **Mortality from measles, 1966–82, England and Wales.**



Source Communicable Disease Statistics.

fall below 50,000 per annum (Figure 2). Indeed, the annual average for 1980–82 exceeded 95,000 in England and Wales. In addition, measles continues to claim between 10 and 20 lives each year (Figure 3).

Measles in the United States

The recent experience of the United States provides a sharp contrast to that of England and Wales. Between 1977 and 1979 a National Childhood Immunisation Initiative was undertaken in an attempt to reduce the large numbers of American children who remained susceptible to one or more of the preventable childhood infections. Within this overall objective a more specific target of eliminating the transmission of indigenous measles was established in October 1978. This goal required the attainment of near universal immunisation rates and this has been achieved: in the autumn of 1981 , 97 per cent of children entering school for the first time had proof of immunity to measles (AJPH 1983). As a result, notified cases fell from 57,345 in 1977 to just 1,697 in 1982, with 94 per cent of the 3,138 counties in the United States reporting themselves in the latter year to be free of the disease.[3]

Notifications of measles per unit of population in the UK were 260 times the level recorded in the US in 1982. This huge disparity may be attributed to both positive factors operating in the US and negative or inhibitory influences in Britain. Focusing on the first group, a major explanation for the achievement of high immunisation rates in the United States lies in the enactment and enforcement of laws requiring proof of immunity to measles as a condition of school entry. Yet such legislative demands aside, it might also be argued that Americans are in any event substantially more responsive to health promotion or disease prevention initiatives than is the case with their British counterparts.[4]

Explaining the UK performance

The explanation for the 'curiously apathetic attitude towards measles vaccination' (Noah 1982) in Britain does not, however, stem solely from a national indifference to the contemporary

3 Of the 1,697 measles cases in the US in 1982, 119 were imported and a further 498 were epidemiologically linked to 19 of these importations. However, imported cases of the disease need not necessarily undermine eradication policies because they may be controlled by the stringent application of traditional public health measures (Middleton 1984).

4 The rapid improvement in US coronary heart disease mortality rates since the late 1960s, for example, is widely attributed to a positive response on the part of the public to the growing evidence that specific behavioural risk factors play a critical aetiological role in the disease and might thus be seen to support this contention.

trend towards healthier lifestyles and the emphasis placed upon the individual's role in promoting his or her own wellbeing. Specific factors have been operating in the context of vaccination and continue to do so. It has, for example, been suggested that the failure of measles vaccination to achieve a higher level of acceptance might reflect some degree of disillusionment with immunisation in general following the whooping cough controversy of the mid-1970s (Smith 1980). Countering this assertion Noah (1982) has pointed out that the episode had little or no damaging effect on the take-up rates for diphtheria, tetanus or polio vaccines. It would, however, be perfectly consistent with the latter observation to suggest that an erosion of both public and professional confidence, intensifying the desire to avoid 'unnecessary risk', might be expected to have a more profound inhibitory impact on a relatively new procedure, the value of which is not widely appreciated, than on those which are well established, safe and demonstrably highly efficacious.

It nevertheless seems likely that other 'measles specific' factors have probably been of greater significance. The perception of measles as a trivial illness is clearly one such factor. Difficulties early in the vaccine's history concerning efficacy and side effects may have exerted an adverse long-term impact on the vaccine's reputation (Noah 1982). Immunisation may be avoided because of apparent contraindications. Yet the latter are fewer in number than is frequently presumed and lead in fact to the exclusion of only 5 per cent of potential recipients (Middleton 1983). Vaccination may also be thought unnecessary because of a 'history' of measles in the initial year of life. There is evidence, however, that this 'inaction' may frequently be inappropriate: Adjaye and her colleagues (1983) reported that two thirds of a sample of 53 children believed to have suffered measles during their first 12 months proved on serological investigation to be vulnerable to the disease. A further obstacle to achieving greater acceptance for measles vaccine lies in the fact that vaccination is delayed until the second year of life when child clinic attendances are considerably fewer in number and thus so too are the opportunities either to administer protection or to discuss its merits.

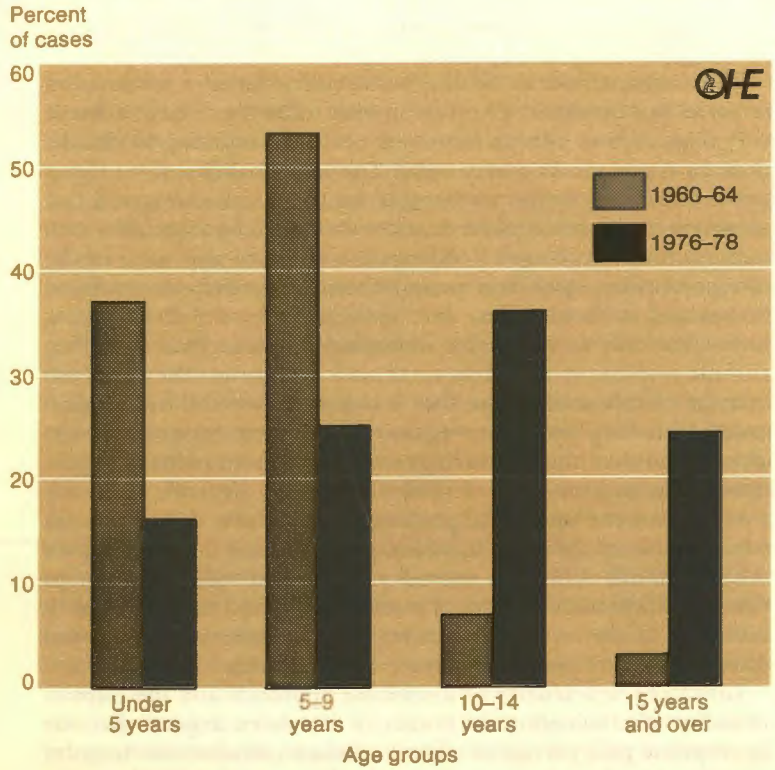
Policy options

The negative impact of the factors outlined above has been exacerbated by disagreement surrounding the appropriate form of a measles vaccination strategy for Britain. A policy of measles eradication, as pursued successfully in the United States, offers substantial benefits in terms of reduced morbidity and mortality,

but is considered impracticable by a number of commentators. The principal barrier lies in attaining the requisite level of vaccine take-up. In the United States, this has been facilitated by legislation but in Britain, where 'the freedom to be ill is valued so highly' (Middleton 1983), intervention along these lines is unlikely to prove acceptable.

Doubts about the feasibility of an elimination policy have also been raised by the possibility that the protection conferred by vaccination in early childhood may diminish over time (Smith 1980). But fifteen year follow-up data from a Medical Research Council trial of vaccine administered to children between 10 months and 2 years of age suggest that fears in this context are unfounded (Miller 1980).

Figure 4 **The shifting age distribution of measles cases in the United States.**



Source Desmyter and Krugman 1980.

Finally, the desirability of the United States' approach has been questioned because of the impact it has had on the epidemiology of the disease. A greater proportion of measles cases now occur in adults and the sequelae of the disease when contracted at a more advanced age tend to be more serious than when it is acquired at younger ages (Griffith 1979). The shift in the age distribution of measles in the United States is clearly demonstrated by data compiled from reports communicated to the Centre for Disease Control in Atlanta. In 1960–64, 37 per cent of measles cases occurred under the age of 5 years and only 3 per cent at and above 15 years of age. By 1976–78, these proportions had changed to 26 per cent and 24 per cent respectively (Figure 4). However, it should be emphasised that this dramatic shift in the age distribution of the disease is a function of a substantially reduced incidence of measles among younger age groups and not the result of major increases among older children. Indeed as the reported incidence for the under 10 age group fell by 94 per cent between 1960–64 and 1976–78, cases among those aged 10–14 years and 15 years or over fell by 55 per cent and 40 per cent respectively (Frank *et al* 1980).

The principal barrier to the pursuit of a measles elimination policy in Britain would therefore appear to be the need to achieve very high vaccine take-up rates – 96 per cent according to calculations by Anderson and May (1982). The improbability of satisfying this requirement in the foreseeable future has encouraged a few commentators who consider measles vaccine to be associated with important disadvantages to advocate a selective approach to the disease. Smith (1980), for example, has suggested that routine immunisation should cease and be replaced by a policy offering protection only to vulnerable individuals, such as those suffering chronic respiratory disorders or Down's syndrome. The supposed benefits of this strategy are that it would enable children to gain assured life-long protection against measles via exposure to the disease and that financial savings would flow from reduced expenditures on vaccines and serological testing. Yet the approach would create the substantial problem of identifying children at risk who require vaccination. It is also uncertain that it would reduce the annual toll of measles mortality (Frank *et al* 1980). But perhaps the most contentious aspect of a selective policy lies in its implicit dismissal of the evidence showing that measles is not a trivial disease devoid of potentially severe complications.

Given the deficiencies of a selective approach and the impracticability of elimination in Britain, it has been argued that the appropriate policy is one of effective disease containment. In order to meet this objective and thus to reduce measles incidence 'to

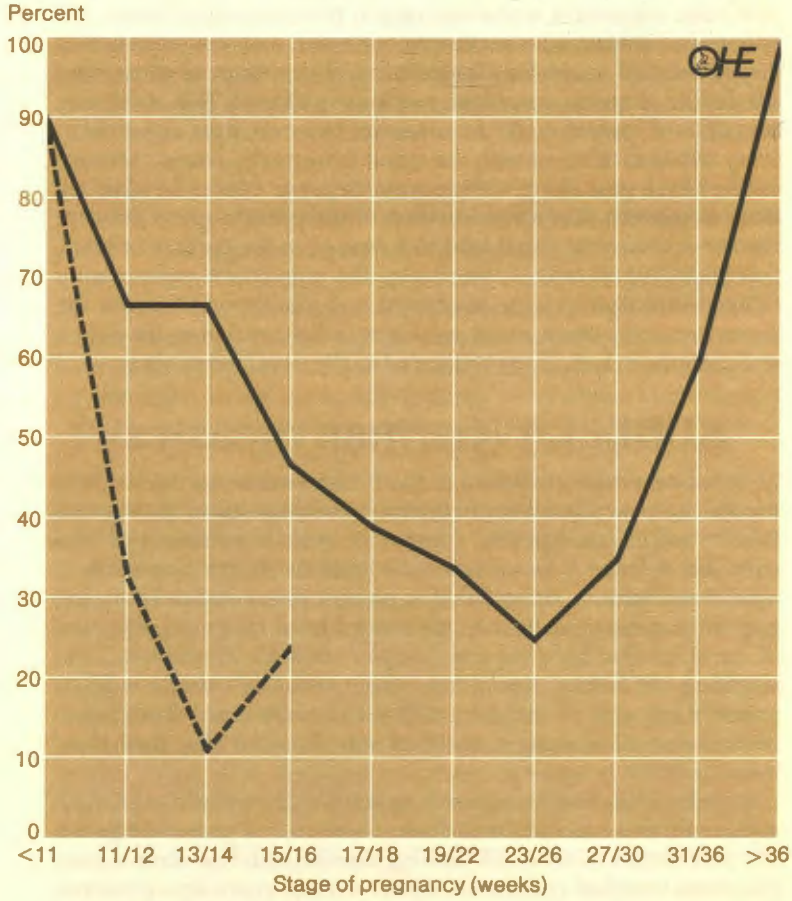
levels at which it is no longer a public health problem' (Noah 1984) vaccine take-up rates of around 80 per cent are probably necessary. At this threshold of acceptance, which experience with diphtheria and polio suggests is a realistic target, protection is afforded not only to individuals who receive vaccine but, as a consequence of the diminished scope for transmission of the virus, to those who are unable to accept, or refuse, vaccination as well. This is the concept of herd immunity. At the moment, however, only one child in every two is vaccinated with the result that nearly 100,000 cases are notified each year along with approximately 20 deaths. In addition, there is concern that a continuation of the present 50–60 per cent vaccine take-up rate could lead to a change in the pattern of infection with a significant proportion of the population experiencing delayed infection in later childhood and adulthood. Because the disease remains much more prevalent in Britain this could yield a real increase in later cases compared to the USA (Zealley 1984).

RUBELLA (German measles)

In a leading article published in the *British Medical Journal* last year Brook (1983) reviewed contemporary immunisation policies in Britain and in the specific context of rubella commented: 'No scientific defence is possible of the current British approach to rubella vaccination. It has failed to protect women of childbearing age, with immense costs in human terms let alone in the provision of services for handicapped people.' Brook's contention that resolving this failure demands a reorientation of policy has given renewed impetus to the debate that has surrounded British procedures for eliminating congenital rubella syndrome (CRS) since their inception in 1970.

Rubella was first recognised as a clinical entity in the mid-eighteenth century and for the next two hundred years was generally perceived as a mild self-limiting disease with few serious complications (Preblud *et al* 1980). A little over 40 years ago, however, an association was reported between rubella contracted during pregnancy and the presence of congenital abnormalities in the offspring of affected mothers (Gregg 1941). The likelihood of a newborn infant being afflicted with such defects, which typically include heart problems, deafness and cataracts, is much greater if maternal infection takes place during the first trimester of pregnancy than at later stages. Miller and her colleagues (1982) have recently estimated that the frequency of congenital infection after symptomatic rubella in the mother during the first 12 weeks of pregnancy is 81 per cent and is accompanied by an overall like-

Figure 5 **Congenital infection rates (–) following symptomatic maternal rubella and overall risk of defect following congenital infection (– –) at successive stages of pregnancy.**



Source Miller *et al* 1982.

lihood of defects of 69 per cent (Figure 5).

Recognition of the teratogenicity of rubella infection stimulated extensive efforts to identify the causative agent involved and this was eventually achieved in 1962 when the virus was isolated. With this success, a preventive approach to the disease became a possibility. Research aimed at this goal commenced against the backdrop of a worldwide rubella epidemic lasting from 1962 to 1965 – which led in the United States alone to 30,000 stillbirths and 20,000

malformed infants (Cooper 1975) – and by 1969 live attenuated rubella vaccines had become available (Dudgeon 1979).

The British strategy

At this point Britain chose the strategy of selective rather than mass immunisation to eliminate congenital rubella syndrome. The decision reflected epidemiological evidence available at the time which suggested that a take-up rate of 90–95 per cent would be required to eliminate the pool of infection. Since this degree of acceptance had never been achieved in the UK for any vaccine and there was concern that the parents of boys would opt out, it was decided to adopt a policy of 'topping-up' naturally acquired immunity, even though it would take a number of years to exert its full impact (Zealley 1984). Consequently, in 1970 live attenuated rubella virus vaccine was made available for the immunisation of girls between their 11th (now 10th) and 14th birthdays, priority being given in the initial phase to girls aged 13 years.

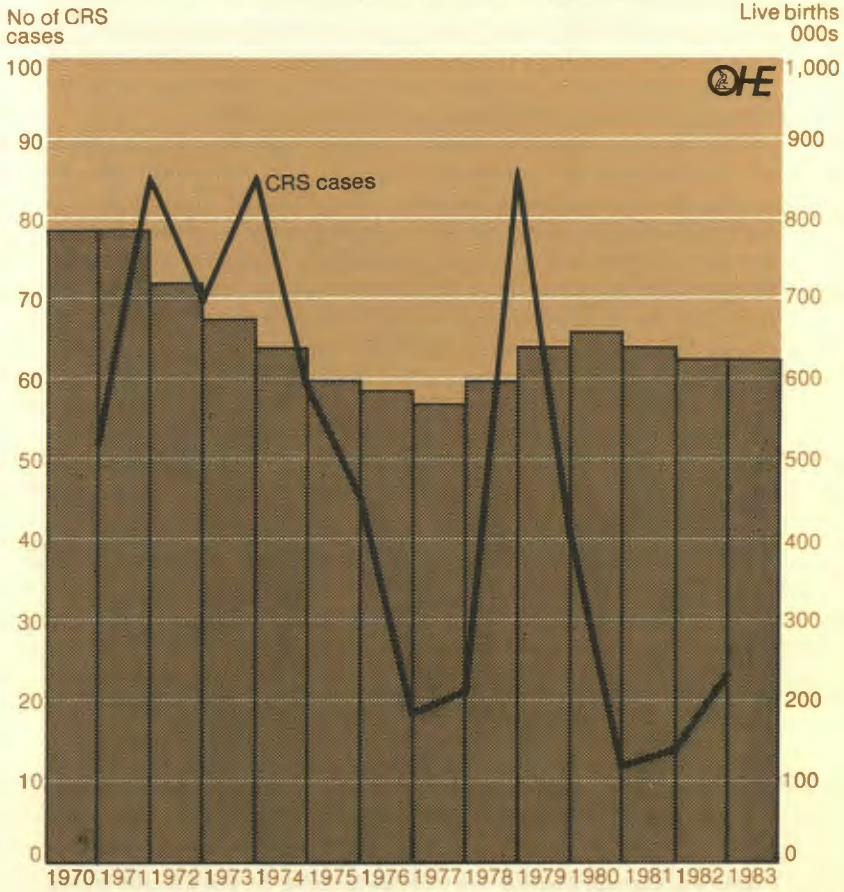
This decision assuaged British concern regarding the duration of vaccine-induced protection because, in rejecting the US approach of immunising children from the age of one year, it meant that between 70 and 80 per cent of women attained childbearing age having acquired immunity via natural infection (Edmond and Zealley 1983). The policy has the additional advantage that the continued existence of wild virus in the community allows for booster reinfections which may be important in maintaining long-term immunity (Badenoch 1984). Finally, it also accommodated fears about the possible teratogenicity of the vaccines by excluding from the programme women already in their reproductive years. In 1972, however, this element of the policy was amended and seronegative women of childbearing age could be vaccinated on request. In 1974 and 1976 the policy towards this group became yet more positive and screening was advocated with vaccination of seronegatives (Noah 1983).[5]

5 Vaccination is offered to women provided they are not pregnant at the time and with the advice that pregnancy should be avoided for the subsequent three months. Rubella vaccine virus can no doubt infect the foetus since it has been recovered from products of conception of susceptible women who abort after vaccination in pregnancy (Hinman *et al* 1983). But evidence is accumulating to suggest that intrauterine infection from this source poses little or no risk to the foetus. In a recently reported United States study of 443 women who received rubella vaccine in the three months before or after conception, none gave birth to a child with defects of the congenital rubella syndrome (MMWR 1982). The maximum theoretical risk of vaccine induced CRS, based on the 95 per cent confidence limits, was three per cent (the observed risk was zero per cent) and is thus substantially less than the risk associated with maternal infection with wild rubella during the first trimester of pregnancy.

Impact of the British approach

The nature of the rubella vaccination policy pursued in Britain since 1970 is such that an unambiguous assessment of its efficacy is not yet possible. Nevertheless, surveys of the immunological status of young females are generally indicative of a favourable impact. Clarke and colleagues (1983), for example, found in a study of 22,000 serum samples collected from university students and young adult blood donors over the period 1969 to 1980 that between 94 per cent and 97 per cent of women born in 1956 or more recently

Figure 6 **Cases of congenital rubella syndrome by year of birth and live births in England and Wales, 1970–83.**



Source Tobin *et al* 1984.

(that is those eligible for rubella vaccine at school) had antibodies against rubella. The corresponding range for males in the same age groups was 80 to 88 per cent. Assuming males would have been equally exposed to rubella as females, this suggests an average net gain due to vaccine of about 12 per cent.

In the same paper the authors also presented data relating to a sample of schoolchildren collected in 1979 and 1980. These demonstrated that at the prevaccination ages of 10 and 11 years between 50 and 60 per cent of both boys and girls possessed natural protection against rubella. Among 15 year olds, however, 94 to 98 per cent of girls were found to be seropositive compared with 70–80 per cent of boys.

Despite these encouraging findings, the principal objective of the vaccination programme, the elimination of congenital rubella syndrome, has still to be accomplished. Suspected cases of congenital rubella are notified under the National Congenital Rubella Surveillance Programme (NCRSP) to one of two centres serving the north and south of the country and up-to-date figures, which have yet to be published, are shown in Figure 6. Following the peak year of 1973–74 (the 'monitoring year' runs from 1 July to 30 June), when 85 affected children were born, there was a reasonably steady decline in incidence until 1977–78. Widespread epidemics then raised the number of confirmed cases to 86 in 1978–79. The most recent estimate is for 1982–83 (23) but this figure, as well as those for the preceding 2 years, should be regarded as provisional because additional cases of hearing loss as a manifestation of intrauterine rubella infection may yet be reported (Smithells 1984).

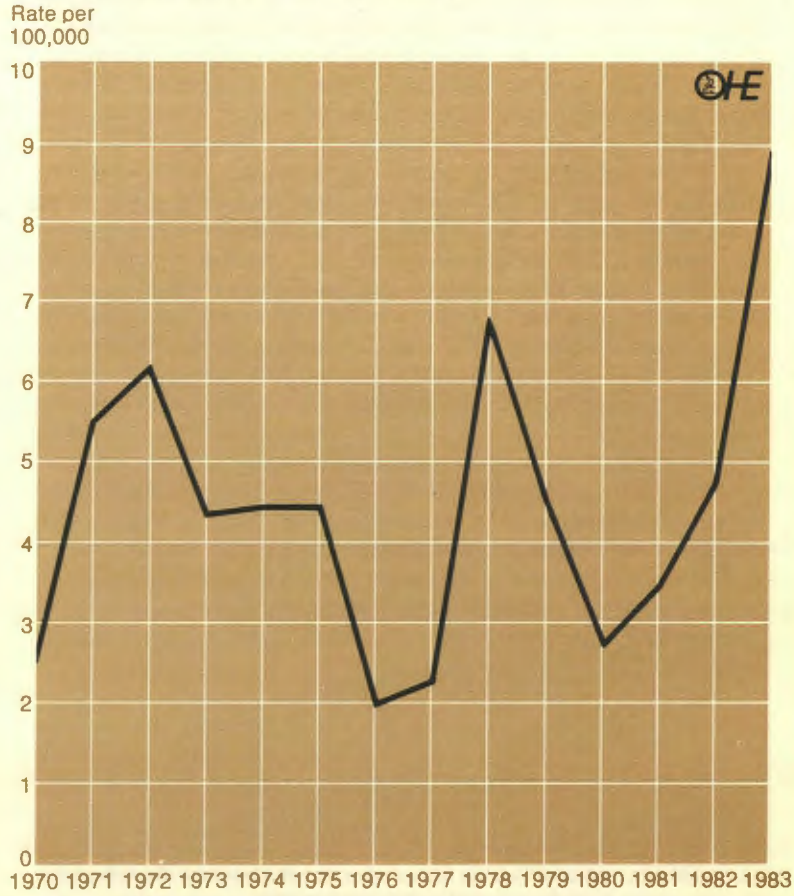
The extent to which these data will have to be revised cannot be predicted with any certainty. However, given the close relationship between the number of CRS cases and the incidence of natural rubella in the population (Smithells *et al* 1982), the data contained in Figure 7 suggest that unless protection among women of childbearing age has increased significantly, the eventual totals for 1982–83 and 1983–84 may be substantially greater than currently indicated.[6]

6 Data relating to the number of legal pregnancy terminations performed each year for rubella associated reasons have also been employed as a guide to the impact of the rubella vaccination programme. Superficially, the data depicted in Figure 8 mirror those generated by the NCRSP and appear to suggest that in the late 1970s the extent of protection against rubella among women of childbearing age was insufficient. However, because factors other than the latter are also reflected in the data, caution has to be exercised in their interpretation.

United States' policy

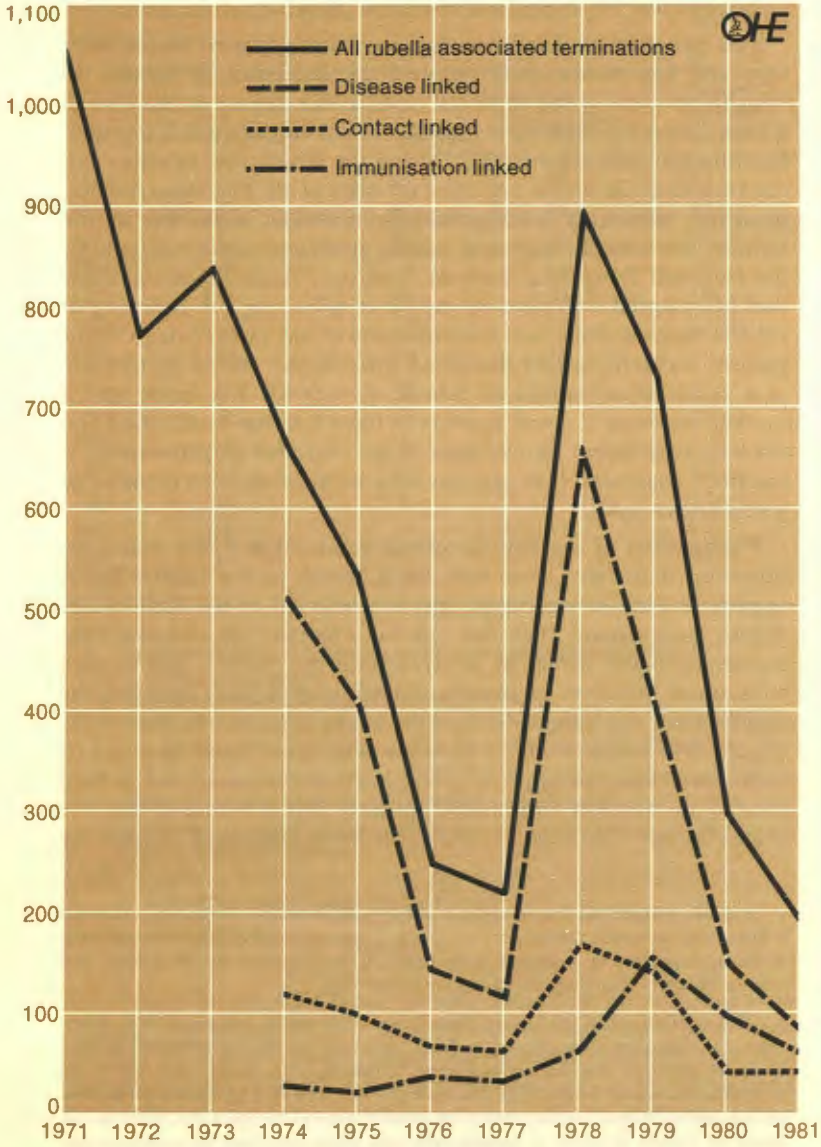
Against this background it has been argued by some commentators that the current rubella immunisation policy targetted only at those at risk will have to be amended if a significant reduction in the incidence of CRS is not to be delayed any longer (Brook 1983, Hinman *et al* 1983). Consequently, there is some support for a shift to the mass approach pursued in the United States. The latter, by vaccinating all infants at the age of 12 to 15 months, seeks to inter-

Figure 7 **Notified cases of rubella, average clinical weekly rate per annum per 100,000, 1970–83.**



Source Tobin *et al* 1984.

Figure 8 **Legal abortions associated with rubella, by type of association, England and Wales, 1971–81.**



Source OPCS.

rupt the transmission of rubella as well as to provide females with protection lasting until and throughout the years of childbearing potential.[7]

This programme has been running in the United States since 1970 and has substantially reduced the incidence of rubella. In 1969, there were 57,686 reported cases of the disease in the United States. Latest available data indicate a provisional total of 954 notifications for 1983 (MMWR 1984). During the latter year, 14 states and the District of Columbia reported no cases at all. The 1970s did not, however, witness a correspondingly dramatic reduction in the number of cases of congenital rubella syndrome. Data collected by the National Congenital Rubella Syndrome Registry (NCRSR) show that after initial decreases in the years following the licensing of rubella vaccine, there was a stabilisation of CRS rates (Table 1). This pattern was temporarily disturbed towards the end of the decade as a result of outbreaks of rubella in 1977–78. But since 1980 a marked downward trend appears to have become established and even though recent figures have to be regarded as provisional, it has been suggested that CRS may now be at or close to record low levels (MMWR 1984).[8]

Protagonists of the British rubella vaccination policy maintain, however, that there is no case for a switch to the United States approach. First, it was in any event predicted at the start of the British programme that the central objective of reducing the incidence of CRS would be delayed until the 1980s – that is until substantial numbers of immunised schoolgirls have entered the childbearing age range. Thus in Britain in 1980, 60 per cent of the 725,024 live births were to mothers who were aged 25 years or more and had consequently not been included in the school rubella vaccination programme. Indeed, if it is assumed that the maternal age distribution of live births in 1980 persists into the

7 It is also pointed out that in order to achieve an immediate impact in terms of a reduced CRS incidence, this long-term strategy if implemented in Britain, would have to be supplemented by a once-off programme of immunisation for all children and women of reproductive age yet to acquire protection.

8 The significance of the United States' data lies more in the trends they reflect than in the absolute values shown in Table 1 because 'passive surveillance' results in underreporting of true disease incidence. In this context, Noah (1983) has drawn attention to a report from the US that between 1975 and 1979 39 cases were notified on average each year for the country as a whole, yet in Chicago alone, after an outbreak of rubella in 1978, 31 infants with CRS were identified by extensive case searching. It has in fact been estimated that only one fifth of confirmed and compatible cases are reported to the NCRSR (MMWR 1984). For this and other reasons, comparisons of incidence data between the US and UK are extremely hazardous.

Table 1 **Congenital rubella syndrome in the United States 1969–83: confirmed and compatible cases by year of birth reported by the NCRSR, numbers and cases per 100,000 live births.**

Year	*Confirmed*[1]	*Compatible*[2]	*Total*	*Rate per 100,000 live births*
1969	23	39	62	1.7
1970	21	47	68	1.8
1971	21	23	44	1.2
1972	15	17	32	1.0
1973	11	19	30	1.0
1974	10	12	22	0.7
1975	19	13	32	1.0
1976	13	10	23	0.7
1977	18	11	29	0.9
1978	19	11	30	0.9
1979	43	14	57	1.6
1980	10	4	14	0.4
1981	6	4	10	0.3
1982	10	1	11	0.3
1983	4	0	4	0.1

Notes

(1) Confirmed cases = defects present and one or more of the following:
- A Rubella virus isolated.
- B Rubella specific immunogloblin M (IgM) present.
- C Rubella haemagglutination-inhibition titre in the infant persisting above and beyond that expected from passive transfer of maternal antibody.

(2) Compatible cases = laboratory data insufficient for confirmation and any two complications listed in A or one from A and one from B:
- A Cataracts/congenital glaucoma, congenital heart disease, loss of hearing, pigmentary retinopathy.
- B Purpura, splenomegaly, jaundice, microcephaly, mental retardation, meningoencephalitis, radiolucent bone disease.

Source MMWR 1984.

immediate future, then it may be calculated that not until 1985 will 75 per cent of live births be to mothers who would have been eligible for rubella immunisation during their schooldays. In 1990 the proportion should have risen to 94 per cent. (At the same time, it should of course be emphasised that 70 to 80 per cent of the unvaccinated group are, in fact, immune.)

Second, there is still some uncertainty about the duration of immunity provided by vaccination (Dudgeon 1983). The United

States policy requires that protection should endure for approximately 40 years, yet early research findings suggested that vaccine immunity might diminish over time (Balfour and Amren 1978). Concern at this possibility has also been expressed more recently by several speakers at the Rubella Symposium held in March this year in Washington (Griffith 1984). However, more encouraging findings in this context have been reported by O'Shea and her colleagues (1984) in a follow-up study of women vaccinated eight to 18 years ago. Against this backdrop of uncertainty, the computer simulations constructed by Knox (1980) to evaluate the outcome of different rubella vaccination policies might be adduced in support of the British approach. The models revealed that very small rates of decay in vaccine immunity would have a considerably more damaging effect on the efficacy of a US style policy than on that adopted in Britain. Furthermore, it was shown that the 'booster' effect of continued wild virus circulation in the community – facilitated by the British but not the US strategy – lessened the loss of effectiveness caused by declining vaccine induced immunity.

Finally, the success of the US policy hinges on the eradication of the reservoir of infection in the community and is thus dependent on extremely high vaccination take-up rates. Data for the early 1980s show that 96 per cent of children entering school in the United States had been vaccinated against rubella (Anderson and May 1983). As in the case of measles this achievement reflects in large part the fact that vaccination is a precondition of school entry. Without the introduction of compulsion into British policy, it is unlikely that a vaccination programme aimed at all pre-school children would achieve the requisite levels of coverage – certainly British experience to date with measles vaccine provides little encouragement in this respect. Consequently, Nelson and Peckham (1983) have expressed the view that 'a change to the American rubella policy could run the risk of increasing the incidence of congenital rubella in this country'.

In view of these considerations it has been argued that it is perfectly consistent for a given vaccination programme to be appropriate to one country but not to another and that the priority in Britain must be to raise the effectiveness of the established vaccination programme. One of the major objectives must therefore be to increase the immunisation acceptance levels among girls aged 10–14 years. Encouraging improvements have occurred in recent years – between 1979 and 1982 the proportion given rubella vaccine in England and Wales increased from 73 per cent to 83 per cent – but the current take-up rate is still short of the DHSS target of 95 per cent. Furthermore, it has to be recognised that the present

Table 2 **Proportion of 16 year old girls in 1974 reported to have received rubella vaccine, by region and social class.**

Region	*Percentage immunised*	*Social class*	*Percentage immunised*
Scotland	81.1	I	66.8
Northern	70.1	II	69.1
East and West Ridings	63.7	III non manual	72.8
North Western	65.5	III manual	74.3
North Midland	71.8	IV	72.9
Midland	69.2	V	66.7
Wales	60.8		
Eastern	72.6		
London and South Eastern	71.1		
Southern	77.7		
South Western	73.6		

Source Peckham *et al* 1977.

acceptance rate is an average and may disguise important regional and social class discrepancies. In 1974, a national sample of girls who would have been 12 years old when the rubella vaccination programme commenced in 1970 found that overall 71 per cent were reported to have been immunised (Peckham *et al* 1977). This proportion varied, however, from 81 per cent in Scotland to 61 per cent in Wales (Table 2).

At the same time, vaccination of the 10 to 20 per cent of susceptible women of childbearing age who do not possess immunity (DHSS 1983) must also remain a priority until all women entering this age range have had the opportunity of acquiring protection via the school immunisation programme. (It may in fact be necessary to retain this aspect of the programme as there appears to be a hard core of around 8 to 10 per cent of children who are not vaccinated under the Schools Scheme because of parental refusal (Banatvala 1982).) One important, albeit non-optimal, opportunity for meeting this objective arises during antenatal clinic attendances. The official goal is to ensure that at least 90 per cent of women found to be seronegative at this time are vaccinated post partum. Yet there is evidence that this opportunity is not being fully exploited. Miller and her colleagues (1982), in their study of the consequences of maternal rubella, found that two thirds of the 1,016 women contracting the disease during pregnancy were multiparous.

WHOOPING COUGH (Pertussis)

The schedule of vaccination and immunisation procedures current during the early 1970s recommended that the three part course of combined pertussis-diphtheria-tetanus vaccine should be commenced after the third month and completed towards the end of the first year of life. There was a high degree of compliance with this advice: official data indicate that almost eight out of every ten children born in 1971 or 1972 received whooping cough vaccine over the following 2 years (Figure 9).

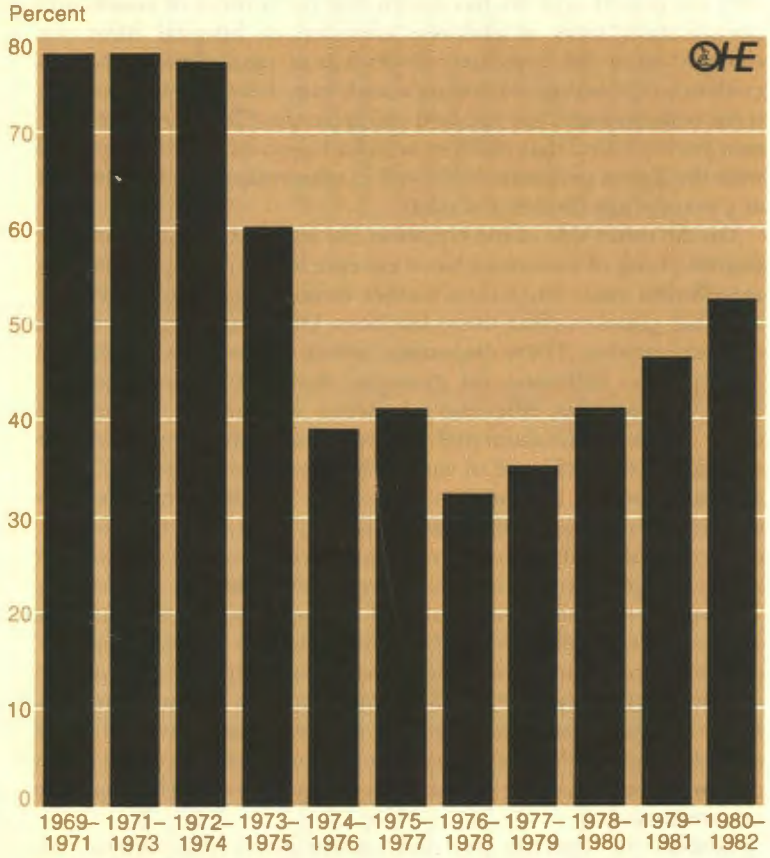
At about this time, however, concern was growing about the safety of the vaccine. From the early days of pertussis vaccination there had been a lingering suspicion of a link between the administration of the vaccine and subsequent occurrence of brain damage in some recipients. Then in 1974 Kulenkampff and her colleagues published a paper describing 36 cases of children admitted to the Hospital for Sick Children in London with severe neurological illnesses: thirty-three of the children were reported to have received pertussis vaccine during the seven days preceding the onset of symptoms. The report and the intensifying debate within the medical profession over the vaccine's safety were accorded extensive coverage by the national press and on television. Widespread parental anxiety followed in the wake of this publicity and the vaccine take-up rate fell dramatically: only three out of every ten children born in 1976 had been immunised two years later. In specific parts of the country the public's loss of confidence in the vaccine was even more marked: in West Glamorgan, for example, the rate dropped to one in ten for children born in 1974 (Swansea Research Unit 1981).

In response to this development, official reviews were undertaken of the evidence concerning the efficacy and safety of whooping cough vaccine. These exercises were judged to have yielded no reason for altering previous advice which recommended the use of the vaccine and statements to this effect were issued in 1974 and 1977. Yet the response to these assurances has been slow: latest available data indicate that half of the nation's newborn children are not protected against whooping cough (Figure 9) and average annual notifications of the disease for 1978–82 were almost four times the level for 1970–74.

Disease and vaccine: costs and benefits

Recent surveys have confirmed that, in spite of the impression that might have been created by declining mortality and therapeutic progress, whooping cough remains a potentially serious disease.

Figure 9 **Vaccination against whooping cough: children born in first year stated and vaccinated by end of second year, Great Britain, 1969–71 to 1980–82, percentages.**



Source *Social Trends* No 14.

An analysis of over 8,000 notifications of the illness between October 1974 and March 1975 found that 10 per cent of cases had to be admitted to hospital (Miller and Fletcher 1976). Among infants aged under six months this proportion increased to 60 per cent and in half of these cases the illness was considered to be severe. The authors commented that 'the crucial factor was seldom the development of pneumonia, which usually responded rapidly to antibiotics, but the paroxysmal cough and vomiting

associated with the primary condition, for which no specific cure is available and which often required intensive care and constant nursing surveillance'. Further research, investigating notifications over the period 1978–80, has shown that the severity of attacks and complication rates in children admitted to hospital have not changed since the first study (Pollock *et al* 1984). Finally, there is evidence that severe whooping cough may have deleterious long term consequences for affected children: the Child Health Education Survey found that children who had been admitted to hospital with the illness performed less well in educational tests carried out at 5 years of age (Butler *et al* 1982).

On the other side of the equation, the first attempt to define the degree of risk of vaccine-induced encephalopathy was published in 1960 (Ström 1960). Since then further estimates have appeared but as Table 3 makes clear there has been little consistency between different reports. These disparities reflect, in part, methodological discrepancies including, for example, the level of case ascertainment and perhaps differences between vaccines over time. But there are more fundamental obstacles to establishing a reliable estimate of the incidence of vaccine-induced encephalopathy. First, pertussis vaccine in common with those for diphtheria, tetanus and poliomyelitis is routinely administered at an age when sudden, unpredictable and often severe clinical events may occur (Griffith 1980). At ages 3 to 15 months, the monthly incidence rate of convulsions, for example, is estimated to range from 0.8 to 1.4 per 1,000 children (World Health Organisation 1984). Acute encephalopathic disorders in young children are extremely rare and may be the result of many different aetiological agents and mechanisms. Even after extensive investigation the cause in individual cases may still remain obscure so that recent immunisation coupled with an absence of any other explanation does not necessarily implicate pertussis vaccine.

Second, in contrast to thalidomide-linked phocomelia, no specific post-pertussis vaccine neurologic syndrome has been identified. It has been reported that immunisation can cause, *inter alia*, acute or sub-acute encephalitis, encephalomyelitis, prolonged convulsions, spasms and Reye's syndrome – yet all of these can also occur in unimmunised children. Furthermore, distinguishing characteristics have not been discerned in terms of the pattern of onset or clinical course of the illness.

Notwithstanding these difficulties, the widespread public and professional concern generated by the reports associating pertussis vaccine with serious neurological reactions culminating in permanent brain damage – and the effect this was having on

Table 3 **Estimates of the frequency of brain damage following pertussis vaccination.**

Ström (1960)	Vaccine induced encephalopathy. Vaccine induced encephalopathy leading to death.	1 per 6,000 injections. 1 per 16,500 injections.
Swedish Royal Medical Board: Malmgren *et al* (1960)	Severe reactions.	1 per 50,000 immunisations.
Ström (1967)	Destructive encephalopathy.	1 per 170,000 immunisations.
Dick (1974)	Brain damage.	1 in 10,000 immunised children.
Prensky (1974)	Severe encephalopathies.	1 in 180,000 immunisations.
Stewart (1977)	Brain damage and mental defect.	Between 1 in 10,000 and 1 in 60,000 immunised children.
Grist (1977)	Permanent mental retardation.	1 in 135,000 immunised children.
Stewart (1979)	Brain damage and mental defect.	Between 1 in 17,000 and 1 in 52,000 immunised children.
Meade *et al* (1981)	Brain damage following any neurological event after vaccination.	1 in 155,000 injections.
NCES (1981)	Persistent neurological damage in previously normal children one year after immunisation.	1 in 310,000 immunisations or 1 per 100,000 children receiving the full course of three injections.

vaccine acceptance rates – created an urgent need to ascertain whether or not a causal relationship existed and, if so, the frequency of its occurrence. The evidence available at that time was considered by the sub-committee on Complications of Vaccination and adjudged to be scientifically inadequate. As a consequence, the National Childhood Encephalopathy Study (NCES) was established. The latter, which ran from June 1976 to July 1979, examined all admissions to hospitals in Britain of children aged between 2 and 36 months with certain acute neurological illnesses, irrespective of the suspected cause. A case-control methodology was adopted with two control children selected for each case and matched for age, sex and area of residence.

The study group's report was published in 1981 and was concerned with the first 1,000 cases investigated (out of a total of 1,180 children admitted over the three year study period). One of the principal findings of the analysis was that 4.1 per cent of the previously normal cases (that is, 32 children) had received diphtheria/ tetanus/pertussis vaccine at some stage during the seven days preceding the onset of illness compared with 1.6 per cent of controls.

It was therefore concluded that there does appear to be a very small risk of serious neurological reaction within seven days of DTP immunisation. The magnitude of this risk was estimated to be one in 110,000 injections, although the authors emphasised that because of the assumptions required to derive this figure, it should not be regarded as a precise measure. It was also emphasised that most of the children experiencing neurotoxic sequelae appear to recover (21 of the 32 case children identified above). Consequently, a more relevant measure might reflect the risk for previously normal children with evidence of persistent neurological damage one year later. This rate was calculated at one in 310,000 immunisations, equivalent to approximately 1 per 100,000 children receiving the full recommended course of 3 injections. These magnitudes of estimated risk are smaller than might have been expected from past studies. In view of these findings the authors concluded that 'most cases of acute and potentially damaging neurological illness in early childhood are attributable to causes other than immunisation . . . It seems likely that permanent damage as a result of pertussis immunisation is a very rare event and attribution of a cause in individual cases is precarious'. And the Joint Committee on Vaccination and Immunisation has therefore concluded on the basis of available evidence that 'the benefits of vaccination greatly outweigh the very small risk of serious neurological reactions which may arise in relation to pertussis vaccine' (JCVI 1984).

Other elements of the debate

The possible neurological sequelae of pertussis vaccine did not, however, constitute the only source of debate during the whooping cough controversy. From mortality data, it was argued, for example, that the decision to promote vaccination on a national scale from 1957 onwards represented an unnecessary intervention. At the start of the twentieth century the death rate from whooping cough among children under 15 years of age was about one per thousand in England and Wales. By the Second World War the rate had fallen to one tenth that prevailing at the turn of the century. The decade spanning the mid-forties to the mid-fifties saw further substantial improvements so that the average annual number of deaths from whooping cough stood at 90 in 1955–56 compared with 749 in 1945–46. Thus mortality from the disease had been declining steeply for more than half a century before 1957 and Stewart, writing in 1977, has argued that further reductions to contemporary levels were predictable from these trends irrespective of the decision to introduce mass vaccination.[9]

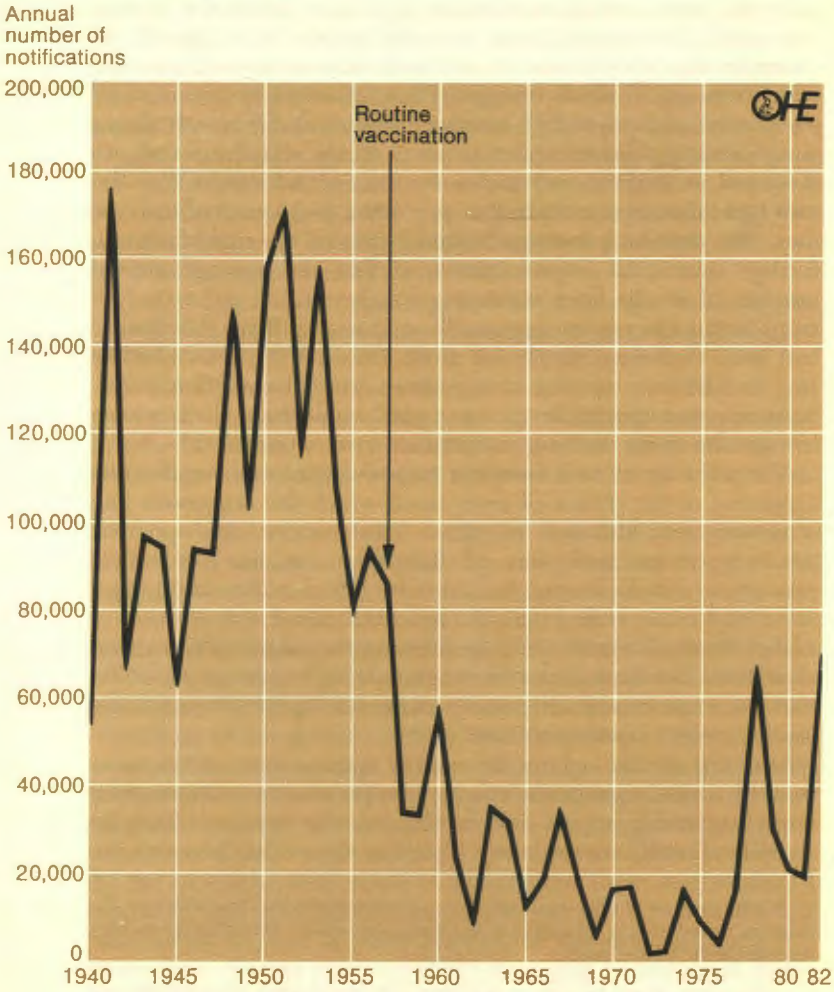
The precision of such forecasts may of course vary significantly according to the choice of years upon which the regression line is constructed (Miller *et al* 1982a). Furthermore, the apparent accuracy of extrapolations of this type may in fact reflect extraneous developments, such as more effective clinical management of disease, rather than the straightforward continuation of earlier trends. Nevertheless, the introduction of pertussis vaccine clearly did not have the same magnitude of impact on mortality that was experienced when vaccines against diphtheria and poliomyelitis entered widespread use.

Mortality trends are not necessarily appropriate criteria, however, by which to gauge the efficacy of a preventive measure and a more favourable impact does in fact become apparent from an analysis of notifications data.[10] Figure 10 shows that between the

9 In 1977 there were 7 deaths from whooping cough in England and Wales but this figure increased to 14 in 1982 when notifications were almost four times the number recorded in the former year.

10 These data should be seen as providing only broad order of magnitude estimates because their accuracy is blunted to some extent by a number of factors. First, notification of episodes is recognised to be incomplete. The West Glamorgan Study (Swansea Research Unit 1981), for example, suggested that reported notifications represent only one quarter of the true rate. Second, some notified cases based on symptoms and illness indicative of whooping cough may in fact be attributable to pathogens other than Bordetella pertussis. Third, reporting patterns may be influenced according to the presence or otherwise of an epidemic and the extent to which it is publicised. Finally, notification data yield no insight into changes in the severity of the disease.

Figure 10 **Notifications of whooping cough, England and Wales, 1940–82.**



Sources JCVI 1981, Health and Personal Social Services Statistics for Wales 1982, On the State of the Public Health 1982.

Note The use of pertussis vaccine was actively promoted on a national scale by the Ministry of Health in 1957. However, in the early 1950s, local authorities had been permitted to use the vaccine at their own discretion.

immediate post war years and 1957 there was no overall increase or decrease in annual notifications. Thereafter, until the second half of the 1970s, regular epidemics continued to occur but they were of progressively diminishing significance with annual notified cases exceeding 35,000 on only one occasion (in 1960).

Efficacy of whooping cough vaccine

The last point suggests that the pertussis vaccine has played a substantial role in reducing whooping cough morbidity but it does at the same time make clear that the availability of vaccine has not resulted in the elimination of the disease. And this highlights another facet of the controversy, namely the question of the vaccine's effectiveness. Stewart (1977), for example, has written that 'the present situation in the UK is that protection by vaccination is, at best partial, probably temporary and seldom if ever complete enough to protect the only group which is seriously at risk – namely infants in crowded houses'. In a more recent paper investigating whooping cough in Glasgow the same author observed that approximately 35 per cent of cases occurred in children who had received a course of pertussis vaccine (Stewart 1981).[11]

There can be little doubt that in the early years of vaccine development findings relating to efficacy were inconsistent. Yet by 1957, following a series of trials conducted under the auspices of the Medical Research Council, it had been possible to establish a British reference vaccine. In 1964, however, the introduction by the World Health Organisation of an International Standard for the vaccine revealed that the potency of the British vaccine was below the recommended level. This observation led the Public Health Laboratory Service to conduct a study from which it was estimated that the protective efficacy of much of the vaccine then in use was less than 20 per cent (PHLS 1969). The vaccine's deficiencies appeared to be explained by its inappropriate serotypic composition (serotypes not previously included in the vaccine had become widely prevalent) and the lack of aluminium adjuvants which enhance potency and reduce side effects.

A vaccine reformulated to remedy these shortfalls was introduced in 1968 and an assessment of the evidence concerning its efficacy by the Joint Committee on Vaccination and Immunisation, published in 1977, concluded that it provided a satisfactory level of protection against the disease, either by preventing its onset or by

11 Extreme caution has to be exercised in assessing the significance of such observations. If, for example, 35 per cent of cases occurred in the 80 per cent of the community vaccinated, it would still imply that the vaccine was more than 80 per cent effective.

substantially reducing its severity in infected individuals. This conclusion has been endorsed by nine or more local studies and even more emphatically, it is argued by the vaccine's protagonists, by the events of the second half of the 1970s. Following the decline in acceptance rates during 1974–76 there was a resurgence of whooping cough notifications – a complete reversal of the trends that might otherwise have been predicted – which culminated in the epidemic of 1977–79. During the latter period 102,500 cases were notified in the UK – higher than for any similar period since whooping cough vaccine was recommended on a national scale.

The protective efficacy of pertussis vaccine is further corroborated by the fact that during the 1977–79 epidemic the attack rate in children over the age of 5 years, and hence vaccinated before 1974, was between a quarter and a fifth that of children under 5 years of age (JCIV 1981). This pattern had not been apparent in other epidemics after 1960. Further, regional analysis reveals that in those areas where acceptance rates were remarkably low the attack rate was substantially higher and vice versa. Finally, a recently published paper describing Japanese experience is also relevant in this context (Sato *et al* 1984). Following the deaths in 1974 and 1975 of two infants after pertussis vaccination, the latter was discontinued. Although vaccination was soon reintroduced for older children, the overall take-up rate fell from 60 to 10 per cent and cases of whooping cough increased considerably: in 1971 206 cases had been notified but by 1979 this figure had risen to 13,105. The authors argued that 'this steep rise . . . indicated the importance and effectiveness of pertussis vaccine'.

In spite of these observations, there is still debate about the safety and efficacy of whooping cough vaccine. It was against a similar background of professional dissent and public confusion that the 1977–79 epidemic developed, infecting 102,500 children and exacting a considerable toll in terms of ill-health: in England and Wales 5,000 children were hospitalised, 50 required admission to intensive care units, 200 developed pneumonia and 83 experienced convulsions induced by the disease. More tragically, 27 children died and 17 were left brain damaged (Hudson 1983). There is considerable concern therefore at the prospect of another epidemic. Yet despite an estimate that only 7 per cent of children might either be advised not to start a course of pertussis immunisation or will fail to complete because of an adverse reaction (Jelley and Nicoll 1984), only one child in every two is currently being vaccinated and 1982 witnessed another 66,000 notifications of the disease – equal to the number recorded in 1978, the peak year of the 1977–79 epidemic – and 14 deaths.

CONCLUSION

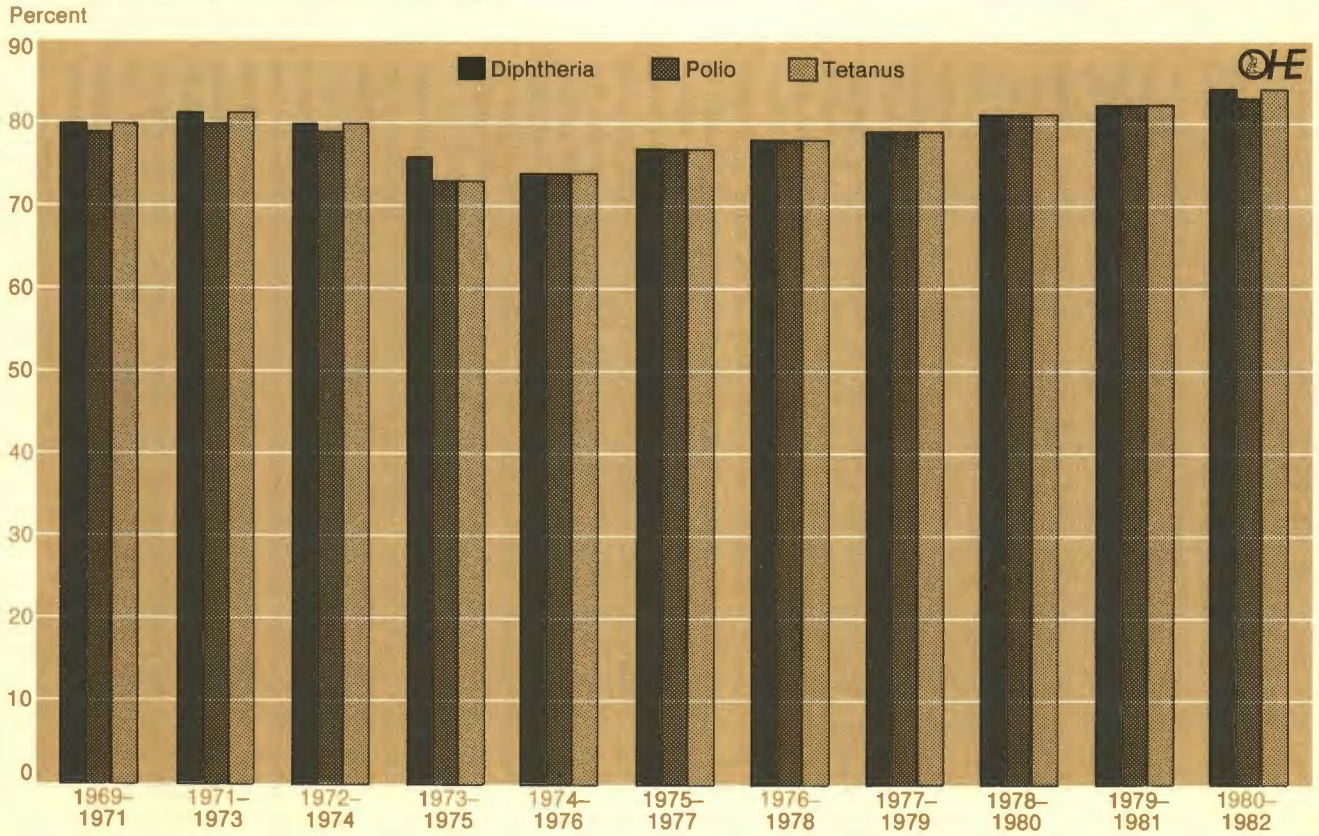
The foregoing should not be taken to imply that vaccination levels are universally inadequate in England and Wales. Take-up rates for diphtheria, poliomyelitis and tetanus vaccines exceed 80 per cent (Figure 11) with the result that notifications for all three combined summed to only 18 in 1982. Furthermore, the data brought together in this paper also suggest that in recent years there has been a slow increase in the acceptance rates for measles, rubella and whooping cough vaccine.

Yet there is considerable scope for improvement. There are, for example, marked differences between regions in the take-up rates for the various vaccines offered in childhood. Thus 84 per cent of children born in England in 1980 had been immunised against diphtheria by 1982 but this overall average disguised a range from 79 per cent in Mersey to 90 per cent in Wessex. For whooping cough vaccination, the interregional disparities were even greater, the take-up rate ranging from 40 per cent in the North Western region to 62 per cent in Oxford.

It is also clear that the three diseases which have been considered in detail in this paper are still responsible for high levels of morbidity. The most up to date information available from official sources indicates that in the first nine months of 1983 there were 17,291 notifications of whooping cough in England and Wales (OPCS 1984). This figure was less than 40 per cent of the total recorded for the equivalent period in 1982. However, epidemics such as that experienced in 1982 (during which notifications for the September quarter reached a level unmatched since June 1957) seem set to recur unless vaccination acceptance rates rise significantly above the present 50 per cent mark.

Focusing on measles, OPCS data show that in the first nine months of 1983 there were 95,908 notifications of the disease in England and Wales. This figure may be compared with 77,273 for the corresponding months of 1982 and 44,678 in 1981. Clearly, 1983 was another epidemic year and notifications seem certain to have exceeded 100,000. In addition to the 15 deaths recorded for the first nine months of 1983, the measles outbreak may therefore be estimated to have caused convulsions in 500–600 children. About 20 children will have suffered encephalitis, five of whom will be permanently brain damaged. Yet despite the fact that the risks of convulsions and encephalitis following measles vaccine are approximately one tenth and one fiftieth respectively those associated with the disease itself, only one child in every two is currently being immunised.

Figure 11 **Vaccination against diphtheria, polio and tetanus: children born in first year and vaccinated by end of second year, Britain, percentages.**



Source *Social Trends* No 14.

Finally, the school rubella immunisation programme is currently achieving a take-up rate which is 12 percentage points below the Department of Health's target of 95 per cent. This shortfall coupled with the fact that many older women are still at risk because they were ineligible for vaccination at school is a major source of concern. Rubella appears to follow a 4 year cycle in which two years of moderate occurrence are superseded by a similar period of much higher incidence. In 1983, the number of cases rose to levels comparable with those observed in 1979, that is, the latter part of the 1978–79 epidemic which resulted in the births of at least 120 rubella-damaged babies and 1,405 abortions associated with the infection (DHSS 1983).

The economic and social burdens to which these diseases give rise cannot be established with any degree of accuracy. Focusing on whooping cough and measles, hospital inpatient (based on 1980 Hospital Inpatient Enquiry data) and general practitioner (assuming two consultations per notification in 1982) costs may be estimated at approximately £3.8 million at March 1984 prices. The social costs, including long-term impairments which incur hardships not only for affected children but for their parents as well, are more substantial yet do not yield to straightforward quantification.[12] The costs of prevention, involving expenditures on campaigns to raise public awareness of the value of immunisation in addition to basic vaccine administration costs, are equally difficult to establish. In the latter context, MacFarlane (1984) has calculated that the cost of primary courses of vaccine for a cohort of 600,000 children (the yearly total of live births in England and Wales) could vary from £11.5 million to £1.25 million, depending on whether the responsibility for vaccination falls to general practitioners or trained nurses. Nevertheless, attempts to set the costs of disease against the benefits of vaccination have clearly demonstrated the value of prevention. Studies quoted by Creese and Henderson (1980) suggest that in the case of measles, for example, the estimated ratio of benefit to cost is about ten to one. Focusing on rubella, Schoenbaum and colleagues (1976) have calculated a benefit: cost ratio of 27:1 for a programme of vaccination of 12 year old girls which achieves an 80 per cent compliance rate.

Ways to increase vaccine take-up

No single explanation exists for the prevailing levels of vaccine acceptance in this country. Instead, a combination of factors

12 Costs for the lifetime care of an infant with congenital rubella syndrome have recently been estimated in the United States to exceed £150,000 (MMWR 1984).

appears to apply in each of the specific cases discussed in this paper. Nevertheless, given the objective of raising vaccine take-up rates three general issues may be identified as requiring attention. The first of these concerns the adequacy of current information about the risks and benefits of vaccination.

It has to be emphasised at the outset, however, that these data have their limitations. For example, the risks of serious adverse vaccine reactions cannot be compared directly with the hazards associated with the disease itself without knowledge in the first instance of the likelihood of contracting the illness. And the latter in turn is, of course, determined to greater or lesser degree by the level of vaccination take-up. This 'interlinkage' implies that an assessment of the relative risks of disease and vaccine would yield a range of values, depending on the various assumptions made, rather than a single definitive answer. In addition, as Miller and his colleagues (1982a) pointed out in the context of whooping cough, 'there will always remain non-quantitative elements in the decision as to whether to advocate the vaccine on a population basis and whether to immunise the individual child'.

Nevertheless better quality data provide a more appropriate foundation for vaccination decisions than anecdotal, outdated or other less well established evidence and it is clear that deficiencies still exist. In the case of whooping cough, for example, whilst the National Childhood Encephalopathy Study generated more reliable, if not conclusive, information about vaccine risk, more data about the sequelae of the disease itself would be valuable. With regard to rubella, further evaluation of the risks of vaccination during pregnancy is required and so too is additional information relating to the duration of protection provided by the vaccine. Furthermore, risk/benefit assessment in the field of vaccination has to be a continuous process because of the steady flow of new data relating to both vaccine safety and disease significance.[13]

It has also been argued that clarification of information relating to vaccine contraindications might be expected to make a positive contribution to efforts aimed at improving vaccination acceptance rates. Interpretation of whooping cough vaccine contraindications, for example, appears to raise difficulties. A survey by Hull (1981) inquired of a sample of general practitioners, health visitors, medical officers (together comprising a group Hull referred to as the

13 With regard to whooping cough, for example, Sato and colleagues (1984) have recently reported the results of a Japanese trial of a potentially safer vaccine (although, as Preston (1984) has pointed out, evidence regarding its protective efficacy against all the pertussis serotypes is still awaited) whilst Johnston and co-workers (1983) have reassessed the pulmonary sequelae of the disease.

'providers'), directors of public health laboratories, general paediatricians and paediatric neurologists (the 'advisers') whether under a variety of circumstances they would advise against whooping cough vaccination. There were 22 questions relating to different clinical situations and the answers revealed that the 'providers' recommended against immunisation approximately twice as frequently as the 'advisers'. To some extent this finding might have been predicted: the former group are at the forefront of attention in the event of the occurrence of severe adverse reactions and are therefore likely to exercise a greater degree of caution in vaccination decisions. Yet the study also revealed substantial discrepancies within the two broad groupings. Consequently, Hull (1981) noted that on many issues 'parents are likely to be given contradictory advice if they seek more than one opinion, and the confusion would not necessarily be resolved by seeking expert advice'. Such confusion, the paper concluded, must be a factor contributing to the low level of whooping cough vaccination.

In the specific context of measles, Campbell (1983) has written that 'most so-called "contraindications" are false and not based on any scientific evidence'. And, more generally, it has been suggested that the whole concept of vaccine contraindications requires reconsideration (Brook 1984).

Improving awareness

In addition to improving the information base upon which vaccination policy is constructed it is apparent that fresh efforts could usefully be channelled into promoting a more accurate understanding of contemporary issues in this field. The success of earlier vaccination strategies has resulted in a greatly diminished public awareness of the risks that may accompany infectious disease in childhood and, coupled with the evolution of effective means of therapeutic intervention, this has led to some degree of apathy towards vaccination. The decline of infectious disease has also had the effect of throwing into much sharper relief the occurrence of severe vaccine reactions. Despite their rarity, considerable media attention has focused on these events and played an important part in reducing public confidence in vaccination procedures. There would appear to be a need, therefore, to correct these 'distortions' – that is, to enhance perception of both the potential sequelae of infectious disease and the true magnitude of the risks accompanying vaccination. The latter may be expressed in absolute terms and in relation to those readily accepted, albeit unconsciously, in the pursuit of many everyday activities. Above all, however, risks must be conveyed in an easily understandable manner

which has impact. In the context of whooping cough, for example, the risks of vaccination calculated from the National Childhood Encephalopathy Study imply that the average general practitioner in the UK would have to continue administering vaccine for 4,200 years before encountering a single case of brain damage for which immunisation might be the cause!

Publicity initiatives such as the current project organised by the National Rubella Council and the proposed campaign against measles (Timmins 1984) can help to raise vaccine acceptance rates by stimulating awareness among the general public. But 'promotional activities' might also be profitably directed at health care professionals involved in vaccination. A survey of general practitioners, clinical medical officers and health visitors in Coventry by Middleton and Pollock (1984) found considerable differences in the practice of measles immunisation. And Jones (1984) has written that 'family doctors are not giving enough active encouragement to parents to have their children vaccinated against measles'. In both instances the authors suggested that their findings reflected in part at least, a tendency to underestimate the potential hazards of the disease as well as uncertainty regarding vaccine contra-indications. Such observations have drawn the suggestion that paediatricians (Campbell 1983) and community physicians (Communicable Disease Report 1983) could usefully play a more active role in encouraging primary health care teams to achieve higher levels of vaccination acceptance by offering information and advice. The former group might also become more actively involved by undertaking immunisations in their clinics and hospital wards if there is concern about individual children and the possibility of reactions (Campbell 1984).

Organisational requirements

Finally, it is of course essential that promoting greater awareness of the benefits of vaccination is underpinned by the availability of a service which is efficient in its organisation and administration and is readily accessible to the public. Inconvenience surrounding clinic attendance, for example, may have a powerful disincentive effect for families for whom vaccination is perceived as the least pressing of priorities. Flexibility might therefore be seen as a key feature of effective service provision. Consequently, identification of the factors explaining the success of certain District Health Authorities in achieving high vaccine take-up rates – in addition to those underlying the extremely low acceptance rates observed for some sub-sections of the population – might prove valuable (MacFarlane 1984a).

Focusing on specific requirements, the achievement of higher vaccination levels necessitates effective monitoring systems to ensure that all individuals who become eligible for immunisation are offered protection and to provide follow-up for those who fail to respond. Such procedures might be expected to prove especially valuable in the case of measles vaccination. The latter is not administered until the second year of life by which time primary vaccination courses have usually been completed for some months and regular health checks have ceased. In Coventry, Middleton and Pollock (1984) have reported that the take-up rate for measles vaccine is only 48 per cent, yet their analysis of immunisation consent forms indicated that 90 per cent of parents express willingness to have their children protected against disease.

The success of monitoring systems themselves is dependent upon a number of factors but one of the key requirements is accurate and complete record keeping. Yet in this respect there have been reports of deficiencies which, if widespread, could constitute a significant barrier to promoting higher vaccine acceptance rates. Smith and Knox (1984), for example, found in one general practice that the immunisation histories shown in the general practice, community child health and health visitor records for a group of children born between 1978 and 1981 were in agreement in only one case in every three. And in another practice study, Gadsby (1980) observed that the general practitioner was not notified when rubella vaccine had been administered to some of his patients.

Clearly, in the absence of appropriate information the objective of maximising potential vaccine acceptance becomes an extremely difficult task. In this respect, well designed computer based systems which maintain a continuously updated record of those eligible for immunisation as well as ensuring that officials are notified when to issue initial or subsequent vaccination appointments, would appear to offer substantial advantages. The benefits of computer assistance in measles (Bussey and Harris 1979) and in general primary/booster (Newman 1983) vaccination programmes have been reported from local studies and the increasing use by health authorities of the immunisation call-up module developed by the Child Health Computing Committee is thus an encouraging development (Rigby 1983). This trend, coupled with a more extensive and enlightened understanding of vaccination issues as well as greater administrative flexibility to promote public acceptance, could pave the way for future reductions in the unnecessarily high volume of childhood morbidity currently attributable to infectious disease.

REFERENCES

Adjaye N, Azad A, Foster M, Marshall W C and Dunn H (1983). *Brit Med J*, 1, 1478.

American Journal of Public Health, (1983). Measles and Rubella: Our Remaining Responsibilities, 75, 5, 490–91.

Anderson R M and May R M (1982). *Science*, 215, 1053–60.

Anderson R M and May R M (1983). *J Hyg Camb*, 90, 259–325.

Badenoch J (1984). *Brit Med J*, 1, 564–65.

Balfour H H and Amren D P (1978). *Am J Dis Child*, 132, 573–77.

Banatvala J E (1982). *Brit Med J*, 1, 1285–86.

Brook C G D (1983). *Brit Med J*, 1, 1082–83.

Brook C G D (1984). Personal Communication.

Bussey A L and Harris A S (1979). *Comm Med*, 1, 29–35.

Butler N R, Golding J, Haslum M and Stewart-Brown S (1982). *J Roy Soc Med*, 75, 781–84.

Campbell A G M (1983). *Arch Dis Child*, 58, 3–5.

Campbell A G M (1984). Personal Communication.

Cherry J D (1980). *Hospital Practice*, July issue, 49–57.

Clarke M, Seagroatt V, Schild G C, Pollock T M, Miller C, Finlay S E and Barbara J A J (1983). *Lancet*, 1, 667–69.

Cockburn W C (1978). Disease Control and Prevention in the 20th Century: The role of Immunisation. In: Proceedings of an International Conference on the Role of the Individual and the Community in the Research, Development and Use of Biologicals, held in Geneva 2–5 March 1976.

Communicable Disease Report (1983). *Comm Med*, 5, 264–67.

Cooper L Z (1975). Congenital Rubella in the United States. In: Infections of the Foetus and Newborn, Eds Krugman S and Gershon A. Alan R Liss Inc, New York.

Creese A L and Henderson R H (1980). *Bulletin of the World Health Organisation*, 58, 491–97.

Department of Health and Social Security (1983). Press release. Ref 83/258, issued 29 November.

Desmyter J and Krugman S (1980). *Brit Med J*, 1, 1185–86.

Dick G (1974). *Proc Roy Soc Med*, 67, 371–72.

Dudgeon J A (1979). Rubella: The UK Experience. In: Immunisation: Benefit versus Risk Factors. *Develop Biol Standard*, 43, 327–38.

Dudgeon J A (1983). *Brit Med J*, 1, 1511.

Edmond E and Zealley H (1983). *Brit Med J*, 1, 1818.

Frank J A, Goodman R A and Hinman A R (1980). *Brit Med J*, 1, 1185.

Gadsby R (1980). *J Roy Coll Gen Pract*, 30, 216, 410–11.

Gregg N M (1941). *Trans Ophthal Soc Aust*, 3, 35–46.

Griffith A H (1979). *Scot Med J*, 24, 42–46.

Griffith A H (1980). *J Roy Coll Phys (Lond)*, 14, 3, 184–89.

Griffith A H (1982). *Brit Med J*, 1, 1263–64.

Griffith A H (1984). Personal Communication.

Grist N R (1977). *Lancet*, 1, 358.

Hinman A R, Bart K J, Orenstein W A and Preblud S R (1983). *Lancet*, 1, 39–41.
Hull D (1981). *Brit Med J*, 2, 1231–33.
Jelley D M and Nicoll A G (1984). *Brit Med J*, 1, 1582–84.
Johnston I D A, Anderson H R, Lambert H P and Patel S (1983). *Lancet*, 2, 1104–08.
Joint Committee on Vaccination and Immunisation (1981). The Whooping Cough Epidemic 1977–79. In: Whooping Cough: Reports from the Committee on Safety of Medicines and the Joint Committee on Vaccination and Immunisation. HMSO.
Joint Committee on Vaccination and Immunisation (1984). Immunisation against infectious disease. HMSO.
Knox E G (1980). *Int J Epid*, 9, 1, 13–23.
Kulenkampff M, Schwartzman J S and Wilson J (1974). *Arch Dis Child*, 49, 46–49.
Lancet (1983). Failure to vaccinate, 2, 1343–44.
MacFarlane J A (1984). *Lancet*, 1, 51.
MacFarlane J A (1984a). Personal Communication.
Malmgren B, Vahlquist B and Zetterstrom R (1960). *Brit Med J*, 2, 1800–01.
Meade T W, Ross E M, Stewart G T, Vessey M P *et al* (1981). The Collection of data relating to adverse reactions to pertussis vaccine. In: Whooping Cough: Reports from the Committee on Safety of Medicines and the Joint Committee on Vaccination and Immunisation. HMSO.
Middleton J D (1983). *Pulse*, 3 December issue.
Middleton J D (1984). Personal Communication.
Middleton J D and Pollock G T (1984). *Lancet*, 1, 167–68.
Miller C L (1978). *Brit Med J*, 1, 1253.
Miller C L (1980). *Brit Med J*, 1, 1451.
Miller C L and Fletcher W B (1976). *Brit Med J*, 1, 117–19.
Miller D L (1964). *Brit Med J*, 2, 75.
Miller D L, Alderslade R and Ross E M (1982a). *Epidemiologic Reviews*, 4, 1–24.
Miller E, Cradock-Watson J E and Pollock T M (1982). *Lancet*, 2, 781–84.
Morbidity and Mortality Weekly Report (1982). Rubella vaccination during pregnancy – United States, 1971–81, 31, 477–81.
Morbidity and Mortality Weekly Report (1984). Rubella and congenital rubella – United States 1983, 33, 237–42.
National Childhood Encephalopathy Study (1981). In: Whooping Cough: Reports from the Committee on Safety of Medicines and the Joint Committee on Vaccination and Immunisation. HMSO.
Nelson D B and Peckham C S (1983). *Brit Med J*, 1, 1818.
Newman C P St J (1983). *Publ Hlth Lond*, 97, 208–13.
Noah N D (1982). *Brit Med J*, 1, 997–98.
Noah N D (1983). Epidemiological aspects of viral vaccines. In: Recent advances in Clinical virology, Ed Waterson A P. Churchill Livingstone.
Noah N D (1984). *Lancet*, 1, 51.
Office of Population Censuses and Surveys (1984). Infectious diseases, September quarter 1983. Monitor MB2 84/2.
O'Shea S, Best J M, Banatvala J E, Marshall W C and Dudgeon J A (1984).

Brit Med J, 1, 1043.
Peckham C S, Marshall W C and Dudgeon J A (1977). *Brit Med J*, 1, 760–61.
Pollock T M, Miller E and Lobb J (1984). *Arch Dis Child*, 59, 162–65.
Preblud S R, Serdula M K, Frank J A, Brandling-Bennett A D and Hinman A R (1980). *Epidemiologic Reviews*, 2, 173–94.
Prensky A L (1974). Developmental Medicine and Child Neurology, 16, 539–43.
Preston N W (1984). *Lancet*, 2, 456.
Public Health Laboratory Service (1969). *Brit Med J*, 4, 329.
Rigby M (1983). *The Health Services*, 12 August issue.
Sato Y, Kimura M and Fukumi H (1984). *Lancet*, 1, 122–26.
Schoenbaum S C, Hyde J N, Bartoshesky L and Crampton K (1976). *N Eng J Med*, 294, 6, 306–10.
Smith H (1980). *Brit Med J*, 1, 766–67.
Smith T (1983). *The Health Services*, 11 March issue.
Smith W C S and Knox J D E (1984). *J Roy Coll Gen Pract*, 34, 260, 160–62.
Smithells R W, Sheppard S, Marshall W C and Milton A (1982). *Brit Med J*, 2, 1363.
Smithells R W (1984). Personal Communications.
Stewart G T (1977). *Lancet*, 1, 234–37.
Stewart G T (1981). *J Epid Comm Hlth*, 35, 139–45.
Ström J (1960). *Brit Med J*, 2, 1184–86.
Ström J (1967). *Brit Med J*, 4, 320–23.
Swansea Research Unit of the Royal College of General Practitioners (1981). *Brit Med J*, 1, 23–26.
Timmins N (1984). *The Times*, 7 April issue.
Tobin J *et al* (1984). Review of Infectious Diseases. IN PRESS.
World Health Organisation (1984). *Weekly Epidemiological Record*, 59, 3, 13–15.
Zealley H E (1984). Personal Communication.

OHE PUBLICATIONS

Studies of Current Health Problems ISSN 0473 8837
58 Reorganised NHS £1.20
59 Preventing Bronchitis 60p
61 Mental Handicap: ways forward 60p
62 Renal Failure: a priority in health? 60p
63 Birth Impairments 60p
64 Scarce Resources in Health Care 60p
65 Schizophrenia: Biochemical impairments, social handicaps 60p
66 Dementia in Old Age 60p
67 Huntington's Chorea 60p
68 Leukaemia: towards control 60p
69 Suicide and Deliberate Self-harm 60p
70 Alcohol: reducing the harm 60p
71 Hip Replacement £1.00
72 Medicines, Health and the Poor World £1.50
73 Coronary Heart Disease £1.00
74 Pharmaceutical Innovation £1.00
75 Understanding the NHS in the 1980s £1.50
76 Childhood vaccination – current controversies £1.00

OHE Briefings
Health Care Research Expenditure 30p
The Cost of the NHS 30p
Renal Dialysis 30p
The Effects of Prescription Charges 30p
Trends in European Health Spending 30p
Disability in Britain – the process of transition 30p
Sickness Absence: a review 30p
Accidents in Childhood 30p
Doctors, Nurses and Midwives in the NHS 50p
Medicine and the Quality of Life 50p
Ill in Europe 50p
Keep on Taking the Tablets? 50p

Reports on OHE Symposia
Medicines for the Year 2000 £5.00
Health Research in England: a topic for debate £2.00
The Second Pharmacological Revolution £7.50
Measuring the Social Benefits of Medicine £7.50

Pharmaceutical Monographs
The Canberra Hypothesis: the economics of the pharmaceutical industry £1.50
Sources of Information for Prescribing Doctors in Britain £1.00
A Question of Balance: benefits and risks of medicines £1.50
The Consumer Movement, Health and the Pharmaceutical Industry £2.00
Issues in Development: a guide £2.00
Future for Pharmaceuticals £2.00

Compendium of Health Statistics. 5th Edition; 1984 £15.00

Research Monographs
Price Comparisons of Identical Products in Japan, the United States and Europe £1.00
Costs and Benefits of Regulating New Product Development in the UK Pharmaceutical Industry £5.00
The Needs of the Pharmaceutical Manufacturers from their Medical Departments in the 1900s £1.50
Patterns of European Diagnoses and Prescribing £5.00

About OHE *free*
Medicines: 50 years of progress *free*