PUBLIC HEALTH

Pertussis—New Zealand 1982/83

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Abstract

Pertussis was prevalent in many parts of New Zealand in 1982 and early 1983. Details of 187 primary family cases and spread within 231 family contacts all aged 11 or under were studied. During the lifetime of these children the pertussis immunisation programme has been two injections of adsorbed triple vaccine at three and five months of age.

All primary family cases were either laboratory confirmed or were contacts of a case within that family who had been laboratory confirmed.

Results reveal that, whilst a significant number of children were protected by immunisation, a substantial number were not. Where infection did occur the clinical condition was likely to be less severe. However, almost all infants of six

months of age or under in the study were not immunised and received no protection.

Various options to vary the pertussis immunisation programme are discussed.

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Introduction

Pertussis is not notifiable in New Zealand. Immunisation often results in modification of the clinical response to infection. Recognition of the condition is thus usually not straightforward nor is laboratory confirmation. For these reasons the incidence of pertussis in New Zealand is not known.

However, an indication of its occurrence and severity can be gauged by hospital discharges and deaths (Table 1).

Table 1.—Hospital discharges and deaths for pertussis. Average/annual numbers and rates per 100 000 population aged 0-9 years* for the quinquennia 1949-1982 and deaths expressed as a percentage of discharges.

Years	Discharges		Deaths		
	n	Rates	n	Rate	Per 100 hospital discharges
1949-53	223	53.6	22.0	5.3	9.9
1954-58	106	21.3	7.8	1.6	7.4
1959-63	117	21.1	3.2	0.6	2.7
1964-68	98	16.2	1.6	0.3	1.6
1969-73	83	13.7	0.8	0.1	1.0
1974-78	146	24.0	0.8	0.1	0.5
1979-82**	195	35.6	0.3	0.1	0.4

* Almost 99% of hospital cases are under 10 years of age.
** four years only. Deaths not recorded for 1982.

Hospital discharges showed a marked decline at the end of the quinquennium 1949-53 but an increase in the periods 1974-78 and 1979-82 to the highest levels since 1949-53.

A breakdown of the quinquennium 1974-78 and the years 1979-82 reveals that in 1974 and 1978 hospital cases reached levels of 221 (rate 36.1) and 254 (rate 43.7) respectively. These were the highest annual figures recorded since 1950 when there were 228 cases (rate 55.7). Numbers and rates fell again in the next three years to the lowest level recorded in the period under review.

However, in 1982 there were 570 hospital cases (provisional estimate) giving a rate of 105. This is the highest on record since 1941 when 600 cases (rate 209) were recorded.

Deaths, however, have shown a progressive decrease from the end of the quinquennium 1949-53. Deaths per 100 hospital discharges show this decline only from the quinquennium 1954-58.

Thus it is apparent that there have been major outbreaks of pertussis in New Zealand at four yearly intervals since 1974.

Immunisation using triple vaccine was introduced in to the departmental programme in 1960. Prior to this a single vaccine or triple vaccine had been used by many practitioners for some years and this, by modifying the severity of the illness, was probably associated with the reduction in hospital cases after the 1949-53 quinquennium. The decline in deaths after the 1949-53 quinquennium is more likely to have been associated with improved management and resuscitative techniques. The majority of hospital cases are under one year of age and many would be too young to have been immunised. Thus modification of the disease by immunisation would have had little to do with survival of these. The fact that death rates per 100 hospital discharges took longer to reduce is also suggestive that this was so.

From 1960 to 1970 immunisation using plain triple vaccine was recommended as a primary course of three injections at three, four and five months of age with a booster dose of double vaccine (diphtheria with tetanus) at 18 months and five years.

In 1971 policy was altered to two injections of triple vaccine at three and five months of age with booster doses of double vaccine as before using adsorbed vaccine.

Following the change from three injections of plain vaccine to two doses of adsorbed vaccine an increased number of hospital cases in 1974, 1978 and 1982 occurred, but deaths due to pertussis have continued to decline.

Whether or not the change over to two doses of adsorbed vaccine from three doses of plain could have been a factor that influenced the increase of cases is a matter for speculation.

Basic to a consideration of programme efficacy is the level to which the population is immunised. Based on claims made for the immunisation benefit an average of 71% of infants received two doses of triple vaccine per year over the years 1977-1982. However results of routine Schick testing suggest that levels are somewhat higher than this.

The outbreak in 1982/83 presented an opportunity to gather information on cases and contacts so that the efficacy of the immunisation programme could be evaluated. In particular, it was desired to determine to what extent the programme provided herd immunity and individual protection.

Method

Medical officers of health were asked to obtain information of cases confirmed by culture of B pertussis from laboratories, practitioners, and hospital paediatric departments. In addition information was requested of household contacts of 11 years of age or under and whether or not these had subsequently or previously, experienced a persistent paroxysmal cough clinically suggestive of whooping cough.

There were a few instances when the laboratory confirmed cases were not the first (primary) case in the household. Where this happened the first case often had not been laboratory confirmed but was diagnosable on clinical grounds and these were included in the study of primary cases with the confirmed case in the contact group. What was common to all families was at least one laboratory confirmed case.

Results

A child was regarded as immunised if two doses of adsorbed vaccine had been given. For one dose or none the child was regarded as not immunised.

Primary household cases: Hospital cases are more likely to receive laboratory confirmation and this is reflected in the present series in which the majority were hospitalised.

Eighty-seven of the 187 cases or just under 50% were aged six months or under (Table 2). Forty percent of cases were immunised. However, infants of six months and under with one exception were not immunised and could expect little or no protection which was the case in this series. Of the older age groups (seven months-11 years) 73% were immunised. Most of these children were in the age bracket seven months-five years and of these 72% had been immunised.

Table 2.—Age and immunisation status of primary household cases (percentages in brackets).

Age	Immunised	Not immunised	Total
0-6 months	1(1)	86(99)	87
7 months-5 years	59(72)	23(28)	82
6-11 years	14(78)	4(22)	18
Total (0-11 years)	74(40)	113(60)	187
(7 months-11 years)	73(73)	27(27)	100

It has long been recognised that immunisation against pertussis may result in modification of the severity of a clinical attack. Table 3 demonstrates that the immunised groups had significantly fewer cases of severe illness ($p < 0.001$) and conversely, significantly more cases of intermediate and mild illness.

Spread within families: As indicated previously household contacts of 11 years of age and under were followed up to determine whether or not they had contracted clinical pertussis.

Results (Table 4) show a significantly greater proportion of unimmunised children contracted pertussis (60% compared with the immunised children 25%) $p < 0.001$. These results indicate a vaccine efficacy of 58% (limits within a 95% confidence level vary between 51.9% and 64.7%).

However, a breakdown of these figures into age groups shows that of 24 contacts of six months of age or under only one was fully immunised. Twenty (all unimmunised) contracted pertussis and the four who didn't included the one immunised infant. Thus not only did 83% of family contacts of six months or under contract pertussis but, with one exception, they were not immunised.

Discussion

Any review of the results of immunisation against pertussis suffers from immediate handicaps. There is a lack of information on incidence magnified by difficulties in diagnosis brought about not only by vaccine modification of the disease but also by the occurrence of similar clinical syndromes due to various viruses as well as problems of laboratory confirmation.

Hospital statistics have, as stated, indicated trends; notably a progressive reduction in deaths to a negligible level as well as fluctuations in hospital cases indicative of levels of infection occurring in the community.

The possible significance of these fluctutations in relation to the immunisation policy has already been mentioned. The extensive outbreaks in 1982/83 offered an opportunity to evaluate the pertussis immunisation programme. In particular it was desired to see whether infants were being protected, to what extent spread occurred in family contacts and whether the vaccine modified the clinical condition if it did not provide complete immunity.

Table 4.—Family contacts of 11 years of age and under contracting and not contracting pertussis in relation to immunisation status (percentage in brackets).

	Immunised	Not immunised	Total
Contracted pertussis	43(25)	34(60)	77
Not contracted pertussis	131(75)	23(40)	154
Total	174	57	231

What role the vaccine itself, the present policy of two injections and/or the level of acceptance had to play in the effectiveness or otherwise of the programme was a matter to be determined. The study has shown quite clearly that the very children most at risk, those of six months of age and under, received little or no protection. The high case incidence demonstrated that in this age group individual protection due to herd immunity was insignificant if it occurred at all.

That 40% of cases of pertussis occurred in the immunised in the primary cases is in keeping with other reviews which are probably not strictly comparable. Most studies refer to three or four doses or more as necessary for full immunisation and in some the vaccine used, whether plain or adsorbed, is in doubt.

In a Finnish study [1] (1972-75) 34% of 119 hospitalised pertussis patients had been fully immunised with four doses. In another study quoted in the same paper (1978-80) of 206 cases of pertussis (mostly outpatients), which were laboratory confirmed, 73% had had three or more injections with triple vaccine (adsorbed). In a study [2] of a Glasgow outbreak between 1977-79, 35% of reported cases in children had received three injections of triple vaccine.

Thus the proportion of immunised primary cases in the New Zealand study does little to suggest whether two or three doses of adsorbed vaccine is advantageous. That 40% of primary cases had been immunised in itself has little significance. As immunisation levels in the community increase so also will the proportion of cases that has been immunised.

The study certainly confirms that immunised children are less likely to suffer a severe illness but comparisons with other studies are difficult due to differing criteria. In a review of 1034 1-2 year olds with pertussis in an English study [2] of an outbreak during 1974/75 3% of fully immunised children suffered a severe attack against 21% of unimmunised children. In the New Zealand study 16% of immunised children had a severe attack against 49% in the unimmunised. This would suggest better modification with three or more injections of vaccine.

Careful study of the occurrence of pertussis in family contacts immunised or not gives a good indication of spread and vaccine efficacy. Overseas studies show considerable variation in vaccine efficacy and these vary depending on the criteria used. Efficacy rates of 94% have been reported in the USA for children under five and 80% in the USSR [1]. Another US report [3] indicates a vaccine efficacy of 82.4% in household contacts of under five years of age (three or more doses of triple vaccine).

Table 3.—Severity of illness and immunisation status of primary household cases (percentages in brackets).

Age	Immunised				Not immunised			
	S	I	M	Total	S	I	M	Total
0-6 mth	0	1(100)	0	1	46(53)	33(38)	7(9)	86
7 mth-11 yr	12(16)	44(58)	19(26)	75	9(33)	16(59)	2(8)	27
Total	12(16)	45(59)	19(25)	76	55(49)	49(43)	9(8)	113

S = severe
I = intermediate
M = mild

However, in two child families in the United Kingdom the efficacy was consistently about 50% in contacts aged 1-5 years despite three injections of adsorbed vaccine in those immunised [4]. The estimated efficacy was 71% if children who suffered ten or more episodes of paroxysmal coughing were included. The figure in the New Zealand study of 58% is at the lower end of the spectrum of overseas reports. The only major difference lies in the number of doses of vaccine given.

Thus the evidence that three injections will increase vaccine efficacy is suggestive but not entirely convincing.

Conclusion

The two dose regime as practised in New Zealand has some merit. It does result in complete protection to some and a modified illness in others. The extent to which it does so compares unfavourably on balance with other countries using three or more doses of vaccine. What it does not do is to provide protection for those at most risk, infants of six months or under.

Any modification of the immunisation programme must be geared to the protection of the infant and must not put the vaccinee at undue risk.

The introduction of a third pertussis vaccination is likely to result in more children suffering side effects and complications of the procedure. On the whole these will be minor in nature. However, the estimated attributable risk of serious neurological disorders has been placed at one in 110 000 injections with sequelae persisting one year later in one in 310 000 injections [2]. If these figures applied in New Zealand an extra injection of pertussis vaccine could result in a child with irreversible neurological damage every second year instead of every third year. That this occurs to this level in New Zealand has not however, been documented. Thus the New Zealand policy of not giving pertussis vaccine after one year of age in a largely elusive effort to protect the infant by increasing herd immunity appears sound. Also, however, high the level of immunisation acceptance is, it is not likely to result in attaining sufficient herd immunity to completely protect the unimmunised infant. Nevertheless more complete coverage with protection and modification of the disease in a greater number of children should be a continuing objective.

The introduction of the injection of an extra dose of vaccine at an earlier age, say six weeks of age, followed by the usual triple adsorbed vaccine at three and five months of age seems a reasonable compromise. Certainly this and a continuing effort to increase the level of immunisation in infants could be the option of choice until such time that a better vaccine becomes available.

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Footnote: The epidemiology advisory committee of the Board of Health has now made recommendations to the Department of Health on pertussis immunisation and these are being considered.

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