

Pertussis in Sweden after the cessation of general immunization in 1979

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Immunization against pertussis was introduced in Sweden in the 1950s and discontinued in 1979. This was followed by a low endemic level of pertussis for 3 years. Thereafter the incidence gradually increased and there were two outbreaks in 1983 and in 1985.

In the period 1980 to 1985 pertussis was confirmed by culture or serology in 36 729 patients of which 11% were younger than 12 months of age and 69% were ages 1 to 6 years. An estimate of the total frequency of pertussis in preschool children was made from reports from a sample of the child health centers. The annual incidence rate per 100 000 population ages 0 to 6 years increased from the 700 cases in 1981 to 3200 in 1985. The ratio of total cases to those reported from the laboratories was 3:1 in 1981 and 2:1 in 1985. The cumulative incidence rate by the average age of 4 years was estimated at 16% of the unimmunized cohort born in 1980 compared with 5% of the immunized cohort born in 1978.

The seriousness of pertussis was evaluated by studying the 2282 pertussis patients hospitalized from 1981 to the end of 1983. Forty-eight percent were infants younger than 12 months of age. Neurologic complications were noted in 4% and pneumonia in 14% of the hospitalized patients. Eleven children received assisted ventilation. Fatal outcomes were reported in 3 children (0.1%), 2 of whom had severe congenital disabilities.

INTRODUCTION

The controversy about pertussis vaccine which has been going on all over the world is still raging. The

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main problem is the risk of serious side reactions to the whole cell vaccine.¹ Nevertheless the authorities of most countries strongly recommend general vaccination for pertussis because they consider that the benefits of vaccination substantially outweigh the risks.²⁻⁶

In a few European countries official or public opinion has been different. In Italy vaccination against pertussis is not practiced.⁷ In the Federal Republic of Germany the policy is different in different regions in Hamburg general vaccination has not been practiced since 1962.⁸ In the United Kingdom the publication of some case reports of vaccine-damaged children³ led to a reduction of vaccination coverage in the mid-1970s in spite of the official recommendation to vaccinate. In Japan the immunization rate temporarily declined to 22% in 1975 and to 14% in 1976, when the age of starting immunization was changed from 2 months to 2 years on account of two deaths possibly related to pertussis vaccination.⁹

In Sweden immunization against pertussis was introduced at the beginning of the 1950s. After 1965 most children received three doses of vaccine against diphtheria, tetanus and pertussis at 4- to 6-week intervals between the ages of 2 or 3 and 6 months. No booster was given later on.

In 1979 pertussis vaccine was withdrawn in Sweden, mainly because its protective efficacy was questioned.^{10,11} The decision to cancel pertussis vaccination was preceded by an intensified surveillance of the current situation, which is still going on.

The aim of this report is to describe the epidemiology of pertussis in Sweden after the cessation of general vaccination in 1979 with special regard to the attack rate and the seriousness in the unimmunized population.

METHODS

Statistics on pertussis are compiled at the Department of Epidemiology, National Bacteriological Laboratory, Stockholm, on the basis of reports from four sources.

1. Reports from the regional medical officers—Since 1911 these monthly reports enumerate patients

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treated for pertussis. Reporting has been compulsory by law since 1953.

2. Reports from the laboratories. Since 1977 all microbiologic laboratories in Sweden have been invited to report all patients with bacteriologically confirmed *Bordetella pertussis* (by culture since 1977 and also by serology since 1980).

3. Reports from the hospitals. Since 1981 patients who have been hospitalized on account of pertussis have been reported with individual data on special forms by all the 29 departments of infectious diseases and also by all the 44 children's hospitals in Sweden. To make this material complete personal inquiries were made to the hospitals in 1984 to check whether every pertussis patient hospitalized in the period 1981 to 1983 had been reported. From this check information was obtained on another 560 patients, i.e. about 25% of the final number of hospitalized patients. Information about patients hospitalized in 1984 and 1985 has not yet been compiled and is therefore not included in the present analysis.

The number of pertussis patients hospitalized in 1980 was obtained from the National Board of Health and Welfare covering 19 of the 24 counties and 81% of the population. From these figures, which were obtained by year of birth, the total number of children born in 1980 who had been hospitalized in 1980 in the whole of Sweden was extrapolated.

4. Reports from the child health centers. Since January, 1982, reports have been sent once a year from a sample of about 300 child health centers on the total number of children per year of birth who are being supervised at the child health center and the number who have had pertussis during the previous year or earlier. The reports are based on the information supplied by the parents and entered in the children's health records. Information was obtained in January, 1982, 1983, 1984 and 1985 concerning an average annual number of 106 000 preschool children (ages 0 to 6 years), covering about 16% of the total child population in Sweden and ranging from 4 to 55% of the child population in 20 of 21 of the total of 24 counties in Sweden.

The cumulative incidence rates and the annual incidence rates were calculated by the number of children by year of birth who were declared to have had pertussis by the end of 1980, 1981, 1982, 1983 and 1984 and who were reported annually in the period 1981 to 1985 (inclusive), as percentages or numbers per 100 000 of the children registered at the participating child health centers. In estimating the annual incidence rate by birth cohorts in 1981, 1982 and 1983, the population of the cohort born during the current year was divided by 2 (Fig. 4).

Mortality from pertussis is surveyed at the National Bureau of Statistics in Stockholm; through the regis-

ter of causes of deaths. The number of deaths caused by pertussis between 1950 and 1980 (inclusive) was obtained from this register. The figures for 1981 to the end of 1983 are based on reports from the hospitals on deaths among the hospitalized patients. Information on deaths in 1984 and 1985 is not available.

BACKGROUND

Vaccine. The diphtheria-tetanus toxoids-pertussis vaccine used in Sweden from 1952 to 1963 contained aluminum phosphate as adjuvant. The adjuvant was removed in 1963 in order to diminish the incidence of local reactions. Between 1969 and 1977 further modifications of the production procedures were introduced. Inactivation of pertussis bacteria by merthiolate was complemented by heat in 1969. Furthermore the method of cultivation of pertussis bacteria was changed from 1972 onwards, from stationary in bubble bottles to agitated in fermentors for 48 to 72 hours. In late 1977 the period of cultivation was further shortened to 20 hours in order to preserve the strain characteristics as measured by the agglutinin content (M Tiru, personal communication).¹²

Immunization coverage. The proportion of children fully immunized with three doses of diphtheria-tetanus toxoids-pertussis vaccine gradually decreased from 90% in 1974 to 83% in 1977 and 1978. Only 12% of those born in 1979 were in time to be fully immunized, because the vaccine was withdrawn in the middle of 1979.¹³ During the 1980s pertussis vaccine has been imported and it is available for high risk children on special permission.

Morbidity before 1979. Since the beginning of the present century the epidemic curves of pertussis cases reported by the regional medical officers have fluctuated, with a peak usually every fourth year and occasionally every third or fifth year (Fig. 1). After 1950 the curve descended from the highest figure of 20 000 reported cases (271 cases per 100 000 population) in 1957 to the lowest figure of 762 (9 cases per 100 000 population) in 1972. After a 10-year period of

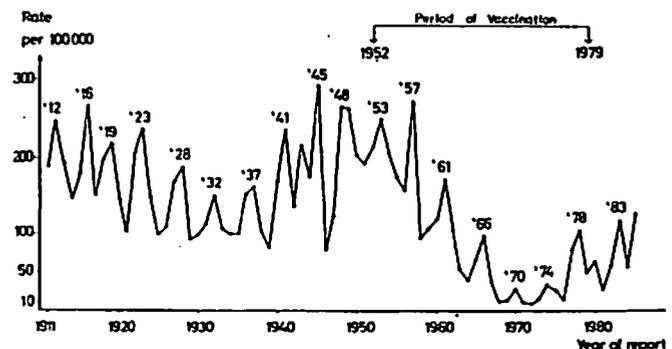


FIG. 1. Pertussis in Sweden. Official statistics from 1911 to 1985. Annual incidence rate per 100 000 of the population of cases reported by the regional medical officers.

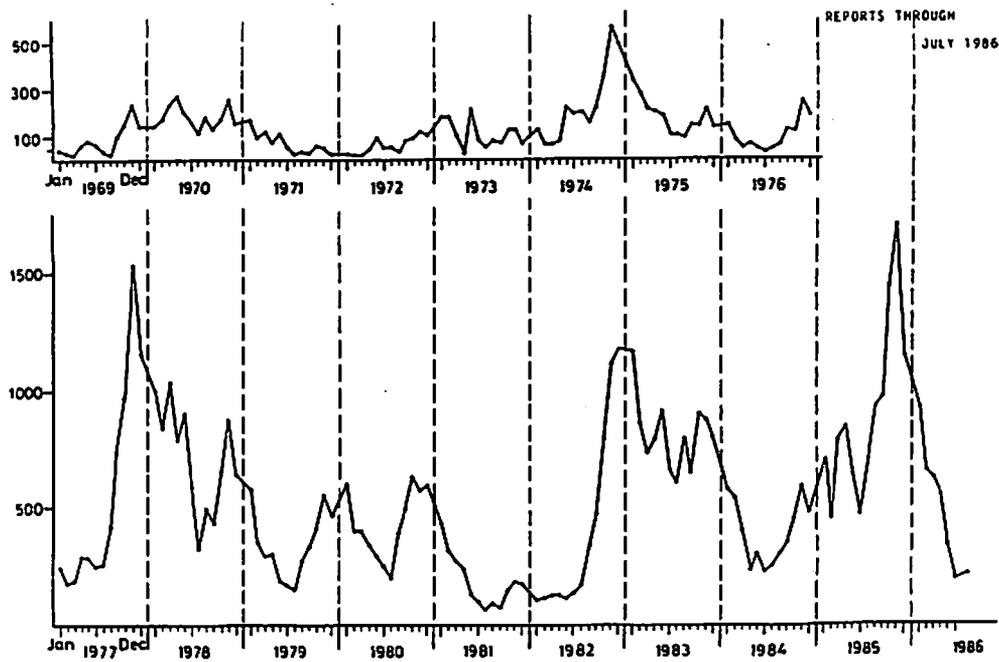


FIG. 2. Pertussis in Sweden. Reports from the regional medical officers, number of cases reported by month in the period from 1969 to the end of July 1986.

rare occurrence an increase was observed in the mid-1970s, culminating in an outbreak which lasted from September, 1977, until the end of 1978, with about 800 cases reported monthly by the regional medical officers (Fig. 2).

Mortality before 1979. Before the introduction of vaccination, mortality from pertussis gradually decreased from about 1000 deaths in 1916 to about 200 deaths annually at the beginning of the 1930s and was further reduced to a total of 90 deaths recorded during the 10-year period from 1950 through 1959 and 12 deaths from 1960 to the end of 1969. Two children died in 1970. In the period 1971 to 1979 (inclusive) one death was reported in an adult suffering from the sequelae of pertussis encephalopathy acquired as a child. However, no death caused by actual pertussis was recorded.¹⁴

RESULTS

Annual and seasonal fluctuations after 1979. The cessation of pertussis vaccination was followed by a relatively calm period with its lowest level in mid-1981, when about 100 cases per month were reported from the regional medical officers. The next outbreaks occurred in the periods from October, 1982, through December, 1983, and from December, 1984, through January, 1986. The peak was observed in November, 1985, comprising 1700 cases reported by the regional medical officers (Fig. 2) and about 1200 cases confirmed by culture (Fig. 3).

Annual incidence rate. Table I shows the annual

incidence of pertussis at all ages and in children ages 0 to 6 years according to the different sources of reports in the period 1980 to 1985. The ratios between the low endemic year 1981 and the two epidemic years, 1983 and 1985, were 1:4.5 to 7, according to the different reports. A pronounced increase in the proportion of bacteriologically confirmed cases was observed in 1985. A correlation between reports from the child health centers and from laboratories is apparent in annual incidence rates by year of birth (Fig. 4). The incidence rate each year was highest in children born in 1980 or 1981 and was low in children born in 1978 compared with those born in 1977 and 1979.

Cumulative incidence of pertussis in the unimmunized birth cohorts of 1980 to 1983. This information according to the different sources, is given in Table 2. The incidence rate per 100 000 person years was estimated in order to take into account the time of observation and also the fact that the different birth cohorts experienced the outbreaks at different ages, thus giving a rough estimate of the average number of cases per birth cohort per year.

Comparison of cumulative incidence of pertussis in immunized and unimmunized birth cohorts. According to reports from the child health centers, 10% of children born in 1977 had shown signs of infection by an average age of 4 years (to the end of 1981), compared with 5% of those born in 1978 by the same age (to the end of 1982) and 16% of those born in 1980 (to the end of 1984) (Fig. 5). The corresponding incidence of bacteriologically confirmed per-

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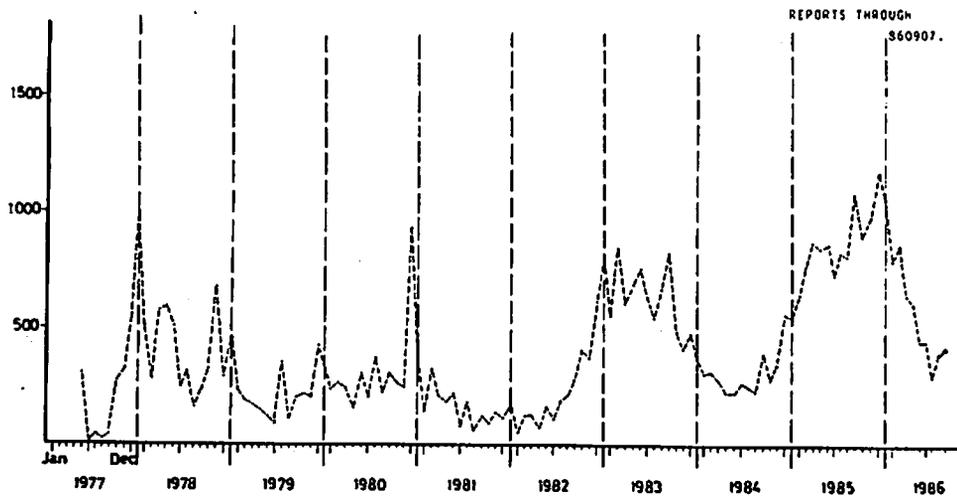


FIG. 3. Pertussis in Sweden. Reports from the laboratories, *B. pertussis* confirmed by culture, number of cases reported every 4 weeks in the period from May, 1977, to the end of August, 1986.

TABLE 1. Pertussis in Sweden in the period 1980-85

Annual incidence rate of cases reported per 100 000 of the population of all ages and of preschool children (0 to 6 years of age). Ratio between the reports from the child health centers and the bacteriologically confirmed cases and the hospitalized patients, respectively.

Reports from	No. of Cases/100 000 of the Population						Target Population on Average
	1980	1981	1982	1983	1984	1985	
All ages	63	27	58	117	57	130	Total: 8 300 000
Regional medical officers							Total
Laboratories (culture or serology)	50	25	47	108	57	153	Total
Hospitals		5	7	16	Not completed		Total
0-6 years		700	1300	2900	1400	3200	Sample: 106 000
Child health centers (CHC)							Total: 657 000
Laboratories (culture or serology) (LAB)	457	236	450	1054	574	1595	Total
Hospitals (HOSP)		58	77	182			Total
Ratio CHC:LAB		3:1	3:1	3:1	2.4:1	2:1	
Ratio CHC:HOSP		12:1	17:1	16:1			

tussis up to the average age of 4 years was 2% of children born in 1977, 0.9% of those born in 1978 and 3.8% of children born in 1980.

Age. In the period 1980 to 1985 (inclusive) 36 729 pertussis cases were bacteriologically confirmed (90% by culture and 10% by serology). On the average 11% were from children younger than 12 months of age and 69% were from children ages 1 to 6 years (Table 3). After 1979 there was a shift of the cases towards the age group younger than 12 months, which decreased in the period 1983 to 1985 in parallel with the increase of the absolute number of cases. In Table 4 are shown the age-specific incidence rates of bacteriologically confirmed pertussis cases in the period 1981 to 1983 in comparison with the age-specific incidence of all pertussis patients hospitalized during the same period. The sex distribution demonstrated a slightly higher rate in females (52% of all cases confirmed by culture and 54% of the patients hospitalized). In adults (>15 years) the majority were females (78% of cases

confirmed by culture and 84% of patients hospitalized).

Seriousness of pertussis. Hospitalization. In 2282 pertussis cases hospitalization was reported during the period from 1981 to the end of 1983. The diagnosis was confirmed by culture in 40% and by serology in 6%. The percentages of bacteriologically confirmed pertussis cases hospitalized were 7% of all cases (all ages) and 31% in children younger than 12 months of age (Table 5).

The 1098 patients hospitalized before the age of 12 months included 552 children younger than 6 months.

The number of cases by month of admission is shown in Fig. 6. Forty-nine of the patients had been admitted to the hospital for reasons other than pertussis (most often surgical problems) but were found also to have pertussis. Half of the patients (1163) were treated in the hospital for 1 to 3 days, while 167 patients (7%) stayed as long as 15 to 65 days (mean, 20 days). The mean duration of the hospital stay was

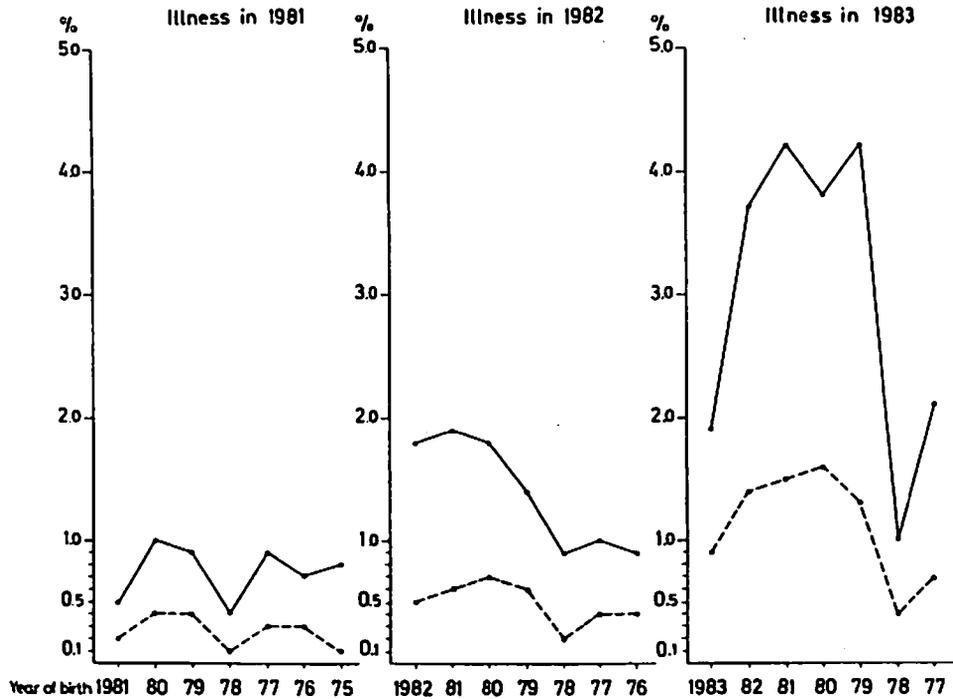


FIG. 4. Annual incidence rate of pertussis in preschool children in 1981, 1982 and 1983 in percentages by year of birth. —, reports from child health centers on a sample of about 15 000 children per year of birth. - - -, reports from the laboratories on the number of cases confirmed by culture or serology in the total child population, on an average, of 96 000 children per year of birth.

TABLE 2. Summary of the cumulative incidence of pertussis in the period 1980 to 1983 (inclusive) in the unimmunized child population born in the period 1980 to 1983 (inclusive)

	Cumulative Incidence of Pertussis to the End of 1983			Target Population Born in 1980 to 1983
	No. of cases	% of N	Rate/100 000 person years	
Reports from child health centers (CHC)	4385	6.8	3370	Sample N = 64 213
Bacteriologically confirmed cases (LAB)	7014	1.9	930	Total N = 375 495
Hospitalized pertussis patients in 1980* + 1981-83 (HOSP)	285 + 1830	0.6	280	Total
Deaths	1	0.0003	0.1	Total
Ratio CHC:LAB:HOSP			12:3:1	

* The number of pertussis patients born in 1980 and hospitalized in 1980 was approximated (see "Methods").

8 days for infants younger than 6 months of age, 6 days for children between 6 and 11 months of age and 4 days for patients older than 12 months.

Complications (Table 6). Neurologic symptoms were reported in 90 patients (4%). Eleven children were considered to have generalized encephalitis. Pneumonia was diagnosed by chest roentgenograph in 321 children (14%). Eleven children (0.5%) including one fatal case received assisted ventilation; all had been born in the period 1979 to 1983. They had pneumonia and 7 also had neurologic complications. According to the available information, another 170 children (7%) received intensive care and/or oxygen or parental nutrition or tube feeding.

Deaths. No deaths were recorded in 1980.¹⁴ Fatal outcomes were reported for three of the pertussis patients hospitalized in the period 1981 to 1983. Two of them, born in 1974 and 1976, were 7 and 6 years of

of them, born in 1974 and 1976, were 7 and 6 years of age, respectively, when they became ill. Both suffered from physical handicaps caused by congenital disease, on account of which they had not been immunized against pertussis. The first child, who had Down's syndrome and associated heart disease with pulmonary hypertension, died of cardiac failure. The second child, who had myelomeningocele with a ventriculo-peritoneal shunt, had shunt dysfunction and died of herniation of the medulla oblongata. The third case, an infant born in 1983, at 4 weeks of age, developed pneumonia with widespread lobar consolidation. She died in spite of antimicrobial treatment and intensive care with assisted ventilation.

DISCUSSION

The outbreak in Sweden in 1977 to 1978 appeared despite high immunization coverage (more than 80%).

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This suggested that the pertussis vaccine had insufficient protective efficacy and the vaccine was withdrawn in the summer of 1979. The next outbreak in 1982 to 1983 occurred in a population in which the 3 or 4 youngest age groups were totally unprotected. The number of reported cases was higher in 1983 and in 1985 than in 1978, but the magnitudes of the epidemics are difficult to compare, because the higher figures in the 1980s might have been influenced by an increased attention to the unimmunized child population, followed by an increased inclination to take specimens and to report cases.

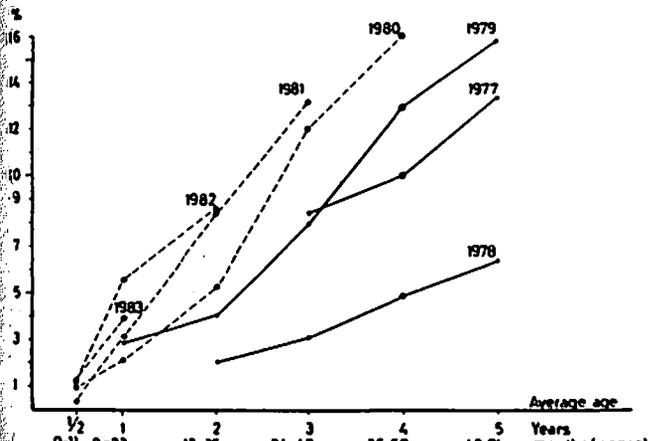


FIG. 5. Cumulative incidence rate of pertussis in percentages by year of birth and average age. ●—●, immunized cohorts born in 1977 and 1978 and partly immunized cohort born in 1979; ○—○, unimmunized cohorts born in the period 1980 to 1983. Number of cases reported from the child health centers by year of birth in percentages of about 15 000 children per birth cohort. Percentages of children who have had pertussis up to the end of 1980, 1981, 1982, 1983 and 1984, respectively.

TABLE 3. Pertussis in Sweden: number of bacteriologically confirmed cases in the period 1977 to 1979 (all by culture), 1980 to 1982 (95% by culture and 5% by serology) and 1983 to 1985 (88% by culture and 12% by serology): percentages of cases in children ages less than 12 months and 1 to 6 years, respectively

Year of Diagnosis	Total No. of Cases Bacteriologically Confirmed	% of Children	
		<12 months	1-6 years
1977-1979	10 588	8.5	70
1980-1982	10 215	12	64
1983-1985	26 514	10	71

TABLE 4. Pertussis in Sweden: age-specific incidence of bacteriologically confirmed pertussis per 100 000 of the population in the period 1981-1983 (inclusive) as compared with the age-specific incidence of all hospitalized pertussis patients (including both bacteriologically confirmed and clinically diagnosed pertussis) during the same period

	Av. Annual No. of Cases/100 000 of the Population by Age (Years)							
	All ages	<1 year	1-4 years	5-9 years	10-14 years	15-19 years	20-49 years	≥50 years
Bacteriologically confirmed pertussis	60	630	670	258	30	5	8	2
Hospitalized pertussis patients	9	395	84	8	0.7	0.4	0.6	0.2

TABLE 5. Pertussis in Sweden: bacteriologically confirmed pertussis cases among pertussis patients hospitalized compared with patients hospitalized among all bacteriologically confirmed pertussis cases in the period 1981 to 1983

	No. of Patients		
	All ages	<1 year	1-4 years
Pertussis patients hospitalized	2 282	1 098	961
Bacteriologically confirmed cases of above	1 056 (46)*	546 (50)	390 (41)
All bacteriologically confirmed pertussis cases	15 057	1 752	7 697
Patients hospitalized of above	1 056 (7)	546 (31)	390 (5)

* Numbers in parentheses, percent of patients.

The data comprise the minimum number of pertussis cases known to have occurred in Sweden between 1977 and 1985 (inclusive), i.e. the total number of bacteriologically confirmed cases and also the total

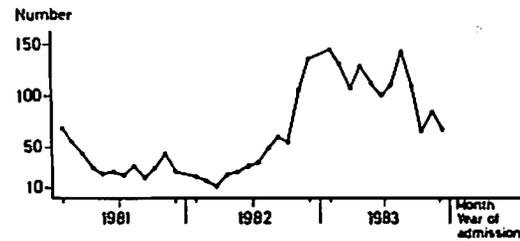


FIG. 6. Pertussis in Sweden. Pertussis patients hospitalized in the period 1981 to 1983, number of patients by month of admission.

TABLE 6. Pertussis in Sweden: complications in pertussis patients hospitalized in the period 1981 to 1983

Complications in Hospitalized Pertussis Patients	Total No. of Cases (N = 2282)	% of N	Total Cases Confirmed by	
			Culture (921)	Serology (only) (135)
Neurological				
Encephalitis (generalized)	11	0.5	5	2
First time convulsions (encephalitis excluded)				
Temperature <38°C	42	1.8	14	8
Temperature ≥38°C	20	0.9	8	1
Convulsions in patients with known epilepsy	11	0.5	6	1
Other, e.g. ataxia, vertigo	6	0.3	2	1
Pneumonia	321	14	125	38
Cardiac symptoms	3	0.1	1	1
Assisted ventilation by respirator	11	0.5	5	4
Deaths	3	0.1	3	

number of pertussis patients hospitalized in the period 1981 to 1983.

The statistics on bacteriologically confirmed cases are influenced by the inclination among different physicians to take specimens in order to make accurate diagnoses, which depend on, among other things, the distance to the laboratory and the epidemic situation. Hospital admission is affected by several factors besides the severity of disease, for example the age of the patient and the parents' ability to take care of the child at home, their confidence that they can do so and also the distance to the hospital.

The two other surveillance methods are limited as regards the diagnostic criteria; the number of bacteriologically confirmed cases and the criteria established for the other cases reported are unknown. Apart from that notifications from the regional medical officers are not a reliable measure of the occurrence of pertussis, because many children with pertussis do not see a doctor. Several cases receiving medical care are not reported either; pediatricians and doctors specializing in infectious diseases, who often treat pertussis patients, are not among those obliged to send in reports.

Reports from the child health centers depend on the readiness of the nurses to ask the parents if and when their children have had pertussis. The diagnosis is uncertain when it is based only on the history received from the parents. The discrepancies in the attack rate as between different birth cohorts may be influenced by the fact that the histories of the youngest children are more reliable, because they have closer contacts with the child health center during their first 12 months of life.

Despite the limitations of the 4 different reports, the results were congruent both as regards the epidemic fluctuations and as regards the annual and cumulative incidence rates. There was a relatively constant relationship between the incidence of cases reported from the laboratories and from the child health centers (ratio, 1:3 to 1:4). Although the reported figures of the occurrence are certainly lower than in reality, they reflect trends. The discrepancies in the incidence as between the different immunized and unimmunized birth cohorts were reproduced repeatedly during five consecutive years in the two different reports, one nationwide from the laboratories and the other from the child health centers based on a sample of children ages 0 to 6 years.

Thus children born in 1978 had a lower pertussis incidence than those born in 1977 or in 1979 and 1980. This may have been due to an improved protective efficacy of the vaccine used in 1978, as compared with the vaccine used in the period 1972 to 1977. The impact of the changing vaccine procedures, leading to improved agglutinin content in late 1977, could not

be evaluated as early as 1979, when it was decided to discontinue vaccination.

It was not possible to compare the seriousness of pertussis in unimmunized children with the seriousness in the immunized population born in the 1970s because information on the pertussis patients hospitalized in the 1970s was not available. The study does not include any long term follow-up to record such possible sequelae as neurologic or pulmonary dysfunction. However, it is on record that all the surviving patients were apparently healthy on leaving the hospital and at the next visit.

However, 1 fatal case of pertussis a year in Sweden must be weighed against the risks of serious sequelae after vaccination with the available whole cell vaccines, 1 case per 100 000 vaccinated children, according to one study in the United Kingdom.³ Other studies have reported higher frequencies of 1:25 000 to 1:50 000 vaccinations.^{1,15-18}

The epidemic peaks in Sweden occurred in parallel with those in the United Kingdom, where two large outbreaks occurred in the period 1977 to 1979 (peak in late 1978) and in 1982 (peak in September, 1982). These outbreaks were declared to have been caused by a sharp decrease of vaccine acceptance from more than 75% in 1974 to about 30% in 1978, followed by a slow increase up to 45% in 1981 and 61% in 1982.¹⁹ The proportion of hospitalized patients in the United Kingdom in the period 1978 to 1980 was estimated at 3%,²⁰ compared with 7% in Sweden in the period 1981 to 1983, but this latter percentage is derived from bacteriologically confirmed cases. The frequency of admission is expected to be lower among the cases with only a clinical diagnosis. The number of deaths (51 in the period 1977 to 1982) in the United Kingdom¹⁹ corresponded to an average annual number of 9 deaths, compared with 1 fatal case a year in Sweden in the period 1981 to 1983. Since the population of the United Kingdom is about 8 times that of Sweden, the mortality would seem to be equally low in both countries.

Our evaluation of pertussis in the unimmunized child population gave an answer to the question of whether pertussis nowadays is a harmless disease which does not demand general vaccination. The present situation regarding pertussis in Sweden and the low efficacy of the antimicrobial treatment²¹ indicate an urgent need to prevent the disease by general vaccination as soon as a safe and effective vaccine is available.

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Comparative efficacy of ceftazidime vs. carbenicillin and amikacin for treatment of neonatal septicemia

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The efficacy and safety of ceftazidime were compared with those of carbenicillin and amikacin in 60 neonates with proved invasive bac-

terial infections. The two treatment groups of patients were comparable with regard to sex, gestational and chronologic ages, associated risk factors, clinical condition on enrollment, focus of infection and bacteriology. *Escherichia coli* was isolated from blood cultures of 31%, *Pseudomonas aeruginosa* from cultures of 25%, *Klebsiella sp.* from cultures of 13% and other

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eated for pertussis. Reporting has been compulsory by law since 1953.

2. Reports from the laboratories. Since 1977 all microbiologic laboratories in Sweden have been invited to report all patients with bacteriologically confirmed *Bordetella pertussis* (by culture since 1977 and also by serology since 1980).

3. Reports from the hospitals. Since 1981 patients who have been hospitalized on account of pertussis have been reported with individual data on special forms by all the 29 departments of infectious diseases and also by all the 44 children's hospitals in Sweden. To make this material complete personal inquiries were made to the hospitals in 1984 to check whether every pertussis patient hospitalized in the period 1981 to 1983 had been reported. From this check information was obtained on another 560 patients, i.e. about 25% of the final number of hospitalized patients. Information about patients hospitalized in 1984 and 1985 has not yet been compiled and is therefore not included in the present analysis.

The number of pertussis patients hospitalized in 1980 was obtained from the National Board of Health and Welfare covering 19 of the 24 counties and 81% of the population. From these figures, which were obtained by year of birth, the total number of children born in 1980 who had been hospitalized in 1980 in the whole of Sweden was extrapolated.

4. Reports from the child health centers. Since January, 1982, reports have been sent once a year from a sample of about 300 child health centers on the total number of children per year of birth who are being supervised at the child health center and the number who have had pertussis during the previous year or earlier. The reports are based on the information supplied by the parents and entered in the children's health records. Information was obtained in January, 1982, 1983, 1984 and 1985 concerning an average annual number of 106 000 preschool children ages 0 to 6 years), covering about 16% of the total child population in Sweden and ranging from 4 to 55% of the child population in 20 of 21 of the total of 24 counties in Sweden.

The cumulative incidence rates and the annual incidence rates were calculated by the number of children by year of birth who were declared to have had pertussis by the end of 1980, 1981, 1982, 1983 and 1984 and who were reported annually in the period 1981 to 1985 (inclusive), as percentages or numbers per 100 000 of the children registered at the participating child health centers. In estimating the annual incidence rate by birth cohorts in 1981, 1982 and 1983, the population of the cohort born during the current year was divided by 2 (Fig. 4).

Mortality from pertussis is surveyed at the National Bureau of Statistics in Stockholm, through the regis-

ter of causes of deaths. The number of deaths caused by pertussis between 1950 and 1980 (inclusive) was obtained from this register. The figures for 1981 to the end of 1983 are based on reports from the hospitals on deaths among the hospitalized patients. Information on deaths in 1984 and 1985 is not available.

BACKGROUND

Vaccine. The diphtheria-tetanus toxoids-pertussis vaccine used in Sweden from 1952 to 1963 contained aluminum phosphate as adjuvant. The adjuvant was removed in 1963 in order to diminish the incidence of local reactions. Between 1969 and 1977 further modifications of the production procedures were introduced. Inactivation of pertussis bacteria by merthiolate was complemented by heat in 1969. Furthermore the method of cultivation of pertussis bacteria was changed from 1972 onwards, from stationary in bubble bottles to agitated in fermentors for 48 to 72 hours. In late 1977 the period of cultivation was further shortened to 20 hours in order to preserve the strain characteristics as measured by the agglutigen content (M Tiru, personal communication).¹²

Immunization coverage. The proportion of children fully immunized with three doses of diphtheria-tetanus toxoids-pertussis vaccine gradually decreased from 90% in 1974 to 83% in 1977 and 1978. Only 12% of those born in 1979 were in time to be fully immunized, because the vaccine was withdrawn in the middle of 1979.¹³ During the 1980s pertussis vaccine has been imported and it is available for high risk children on special permission.

Morbidity before 1979. Since the beginning of the present century the epidemic curves of pertussis cases reported by the regional medical officers have fluctuated, with a peak usually every fourth year and occasionally every third or fifth year (Fig. 1). After 1950 the curve descended from the highest figure of 20 000 reported cases (271 cases per 100 000 population) in 1957 to the lowest figure of 762 (9 cases per 100 000 population) in 1972. After a 10-year period of

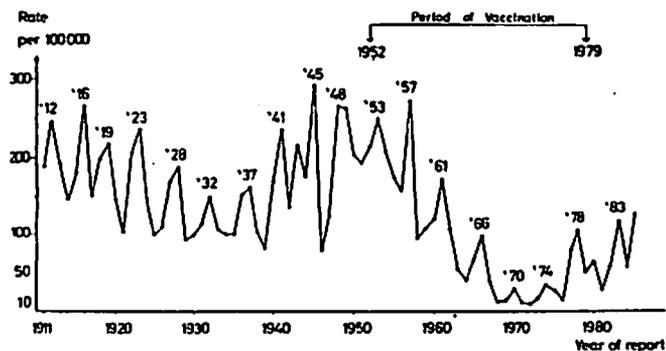


FIG. 1. Pertussis in Sweden. Official statistics from 1911 to 1985. Annual incidence rate per 100 000 of the population of cases reported by the regional medical officers.