THE NATIONAL CHILDHOOD IMMUNISATION PROGRAMMES IN SINGAPORE

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SYNOPSIS

The current national immunisation programmes in Singapore cover seven diseases. It first started with smallpox in 1862, diphtheria in 1938, BCG in 1957, poliomyelitis in 1958, pertussis and tetanus in 1959 and measles and rubella in 1976. In the formulation of the programmes, considerations were given to the epidemiology of the disease to be protected (verified by sero-epidemiological surveys whenever possible), efficacy and safety of the vaccine and cost-effectiveness. The strategies adopted in the implementation of the programmes included expansion of the primary health care services, intensive health education campaigns, checking of vaccination certificates during primary school registration and law enforcement. The programmes were periodically evaluated and amendments made whenever necessary. The comprehensive coverage of the programmes in which more than 85% of the infants were vaccinated annually, has led to the virtual elimination of almost all the diseases protected : indigenous smallpox was last reported in 1959, diphtheria in 1974, paralytic poliomyelitis and childhood tuberculous meningitis in 1978. Eradication of measles would require the immunisation of about 95% of each year's cohort of children at an average age of two years, while it is still too early to assess the effectiveness of the rubella vaccination programme in the prevention of congenital rubella. The reappearance of four indigenous cases of diptheria in unimmunised children in 1982 should serve as a reminder that the excellent immunisation coverage so arduously acquired over the years has to be maintained.

In Singapore, vaccinations are routinely carried out against diphtheria, pertussis, tatanus, poliomyelitis, tuberculosis (TB), measles and rubella. At present, only diphtheria immunisation is compulsory by law; the others are offered on a voluntary basis. Since 1959, it has been a routine procedure to incorporate pertussis and tetanus vaccines into diphtheria vaccine and used in the form of triple antigen (DPT) or diptheria/tetanus (DT) vaccines while poliovirus vaccine is scheduled to be given together with diphtheria vaccine to infants. The comprehensive coverage of the national immunisation programmes has led to the virtual elimination of diphtheria, pertussis, tetanus and poliomyelitis from Singapore.

BACKGROUND INFORMATION

SMALLPOX

Vaccination against smallpox was first offered to the public in 1862. It was made compulsory under the Vaccination Ordinance which was enacted in 1868 and came into force in 1869. The work was carried out mainly by the Colonial Surgeon, his assistants and public vaccinators (1-4). In 1913, vaccinations in the municipal area became the responsibility of the Municipal Health Department and the Municipal Health Officer and his deputy were appointed Deputy Superintendants of Vaccination by the Colonial Surgeon. This continued until 1960 when the Government and Municipal Health Services were integrated into one (5).

With the impending global eradication of smallpox in 1978, the need for routine smallpox vaccination of children in Singapore was carefully considered on 14 June 1979. At the time, it was agreed that if the smallpox vaccination programme for children were stopped, and smallpox vaccination ever become necessary in future (eg. for travel or during epidemics), adults given primary vaccination would have a greater risk of contracting encephalitis : the risk after primary vaccination has been estimated to be 1 in 3,000 in the West (6). In the Singapore context, a vaccination campaign for the population in future could give rise to 400 — 800 cases of encephalitis. The social cost and political implications would be tremendous. On the other hand, newborn vaccinees suffer very little and have almost no fever following vaccination, because transferred maternal antibodies attenuate the vaccination response and reduce the frequency of serious complications. The incidence of post-vaccinial encephalitis in Singapore has been estimated to be 10 per million (7,8). Furthermore, the high vaccination coverage of children would provide the residual immunity necessary for immediate booster should revaccination be required during an outbreak. Therefore, a cautious attitude was adopted as it was felt that it would be premature to withdraw the smallpox vaccination for children at that time.

When global eradication of smallpox has been achieved and officially endorsed by the World Health Assembly in May 1980, discontinuation of routine smallpox vaccination of children in Singapore was recommended. On 6 March 1981, relevant sections of the legislation were amended and smallpox vaccination became no longer compulsory by law.

DIPHTHERIA

Diphtheria has long been endemic in Singapore. It was recognised as a serious childhood disease as early as 1900. During the period 1954 — 1964, an average of 490 cases with 37 deaths occurred annually. The morbidity rate was 11.3 — 50.8 per 100,000; the mortality rate, 0.9 — 4.4 per 100,000; and the case fatality rate 4.5 — 11.2%. Subsequent to a marked increase in the emphasis given to immunisation after 1965, the incidence of diphtheria fell dramatically and the last fatal case was reported in 1970.

The age distribution of cases by age in the period 1965 — 1974 was as follows: 0 — 4 years, 57.1%; 5 — 14, 33.4%; 15 — 24, 5.3%; 25 — 34, 1.8%; 35 — 44, 1.4% and over 45 years, 1.0%. Both sexes were equally affected and the ethnic distribution was Chinese 68.8%, Malays 22.4%, Indians 8.4% and 'Others' 0.4%. Cases were widely distributed over the island, although more numerous in urban areas. No seasonal pattern was observed. The *mitis* strain of *Corynebacterium diphtheriae* was the most prevalent and *intermedius* strains very rare. Only a few *gravis* strains were isolated and a number of these proved to be non-toxigenic (9).

As more and more detailed epidemiological investigations of cases were carried out (10), the proportion of nasal, aural and cutaneous diphtheria diagnosed gradually increased (Table 1). Prior to 1965, more than 70% of the cases were faucial, pharyngeal and laryngeal diphtheria but the picture has gradually changed and, since 1971, the nasal, aural and cutaneous forms of the disease have constituted 60 — 85% of the cases.

TABLE : 1 CLINICAL TYPES OF REPORTED DIPHTHERIA CASES IN SINGAPORE, 1965-1974

YEAR	CLINICAL TYPES				TOTAL
	Faucial, Pharyngeal and Laryngeal		Nasal, Aural and Cutaneous		
	Cases	%	Cases	%	
1965	158	68.7	72	31.3	230
1966	95	44.0	121	56.0	216
1967	70	31.8	150	68.2	220
1968	25	41.7	35	58.3	60
1969	26	39.4	40	60.6	66
1970	22	42.3	30	57.7	52
1971	8	33.3	16	66.7	24
1972	1	14.3	6	85.7	7
1973	2	40	3	60	5
1974	1	25	3	75	4
ALL YEARS	408	46.2	476	53.8	884

Diphtheria immunisation was first made available in Singapore in 1938 under the control of the Municipal Maternal & Child Health Department (11). At that time, as many as 2% of throat swabs from children under ten years of age who had died were positive for *Corynebacterium diphtheriae*. In addition, Schick tests conducted on children about one year of age showed practically no immunity (12). For various reasons such as side effects of immunisation and general apathy, the programme was far from successful despite campaigns in 1952 and 1954 (13). Legislation introduced in April 1962 made immunisation compulsory within 12 months of birth and for any child under seven years not already immunised. It provided for booster doses at four years of age and within 12 months of entering primary school. Even though prosecution would have been possible, it was not resorted to, and every effort was made to persuade parents to cooperate. It was difficult at first to reach the goal of 75% of all infants under 12 months of age, but 70 — 90% were immunised within the first two years of life. Immunisation of school entrants as from 1964 was at first mostly primary immunisation, but as more and more preschool children were covered, booster injections became more common (14,15), and, by 1974, 92% of entrants were given boosters and 3.5% primary immunisation. The decline in diphtheria morbidity and mortality, leading to its virtual eradication from Singapore would seem directly attributed to the successful implementation of the national childhood immunisation programme (15), and the coverage of the susceptible child population should not be allowed to fall below 80% (Fig. 1). The relationship between the incidence of diphtheria and the proportion of infants immunised is shown in Fig. 2.

Fig 1

Incidence per 100,000 population from Diphtheria and immunisation coverage rates, Singapore, 1946-1982.

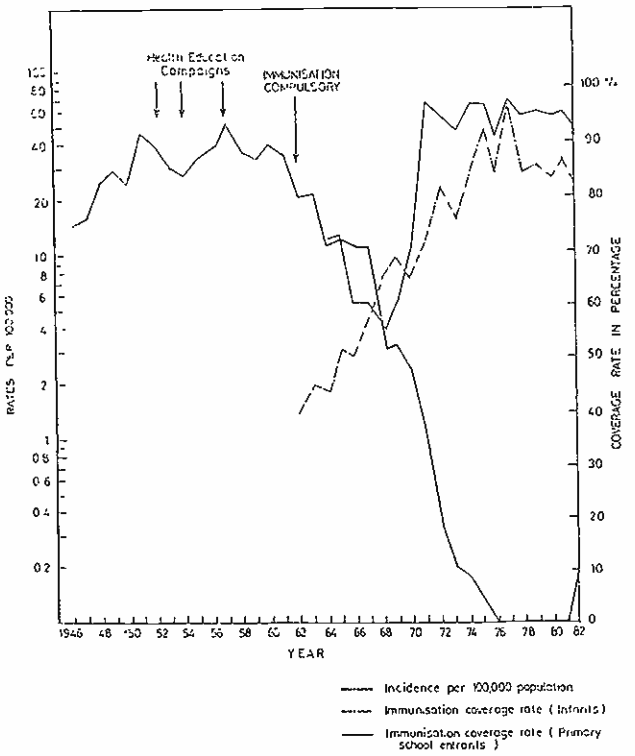
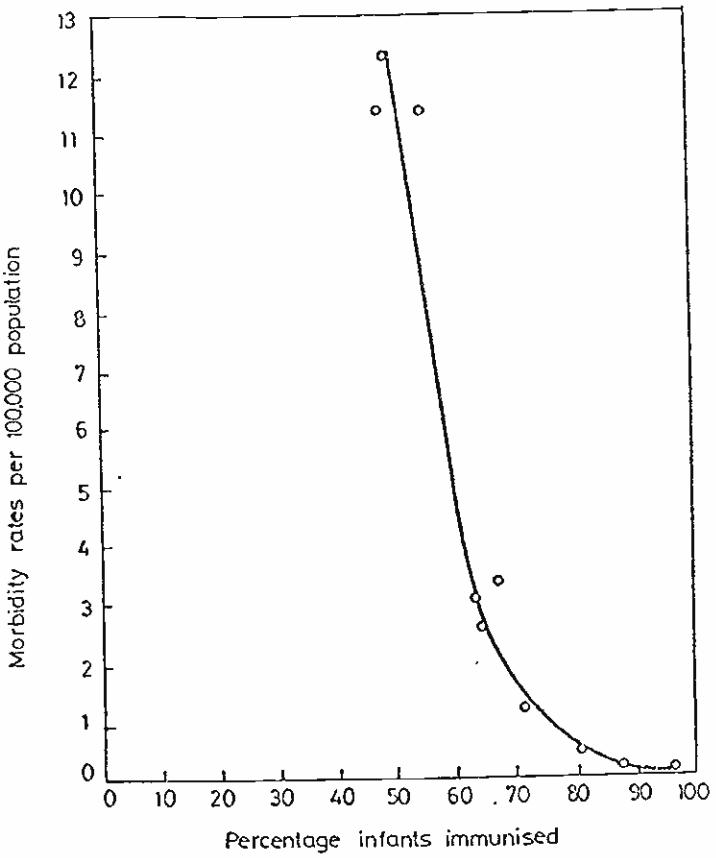


Fig 2.

The effect of diphtheria immunisation on the disease incidence, Singapore, 1965-1974



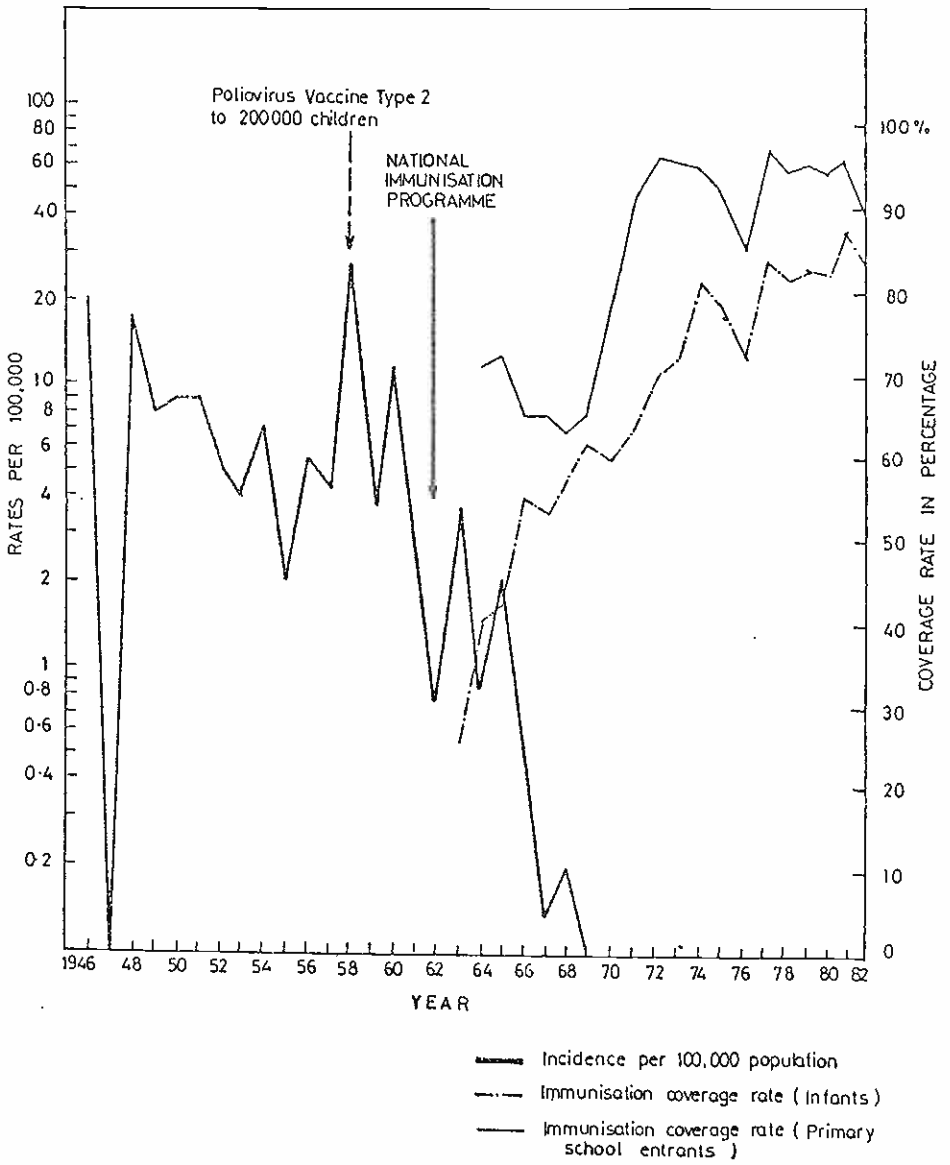
POLIOMYELITIS

Poliomyelitis was a major public health problem in Singapore during the immediate post-war years with epidemics occurring periodically. Immunisation against poliomyelitis using the oral vaccine was first used on a mass scale in 1958 to abort a raging epidemic of 415 cases (17). Poliovirus type 2 vaccines were fed on a voluntary basis to 200,000 children between three months and ten years of age to provide protection by interfering with the establishment of infection by the epidemic type 1 virus. This led to a successful reduction in the risk of paralytic poliomyelitis (18,19). Comprehensive sero-epidemiological surveys conducted showed that there was extensive infection in the very young and that poliovirus type 1 was responsible for the majority of the cases and for the epidemic waves; poliovirus type 3 was of minor importance; while poliovirus type 2 relatively unimportant (20). The age pattern of reported cases showed that children below five years of age were at the highest risk, especially those between six months and two years of age.

The first phase of the national poliovirus vaccination programme began in March 1962 after another epidemic of 196 cases occurred in 1960. Two doses of trivalent vaccines were offered on a voluntary basis to children from six months to five years of age. Serological studies revealed that 98.5% of those vaccinated showed seroconversion to poliovirus type 2; 50.0% to type 1 and 58.8% to type 3. This finding led to the modification of the immunisation schedule during the second phase beginning in March 1963. Infants between three months and five months were given a primary course of three doses followed by a booster one year later and at four years of age. The first two doses of the primary course comprised types 1 and 3 poliovirus since type 2 virus of the trivalent vaccine mixture was shown to interfere with the immune response of the other types (21). In 1964, the vaccination programme was extended to primary school entrants. The coverage had been good and no cases occurred in those with a complete course of primary immunisation (22). To enhance and maintain the immunity of the population, the programme was further extended to primary school and secondary school leavers in 1976. Over the last decade, more than 90% of infants were immunised against poliomyelitis on a voluntary basis (Fig. 3). The current immunisation programme is believed to confer immunity in 90% of the population up to the age of 25 years (20), although some of those who missed the programme could constitute a group susceptible to poliomyelitis (23).

Fig 3.

Incidence per 100,000 population from Poliomyelitis and immunisation coverage rates, Singapore, 1946-1982.



TUBERCULOSIS

BCG vaccination was first used in Singapore in 1951 in a small pilot project through the auspices of UNICEF (24,25). A tuberculin survey conducted in 1951/1952 revealed that by the age of seven years, 50% of the children were positive reactors (26). A systematic mass BCG vaccination programme was implemented in 1957 for all newborns in Kandang Kerbau Maternity Hospital and gradually extended to the City and Rural Maternal & Child Health Clinics. Since 1957, it has been the policy to administer BCG to all Mantoux non-reactors in primary school entrants (6+ years), primary school leavers (11+ years) and secondary school leavers (15+ years). In 1969, BCG was given to negative reactors only if they had not been previously vaccinated, as it was believed that BCG confers a high degree of protection for at least a decade (27). As a rule, not more than two BCG vaccinations were given to anyone person in Singapore. Although BCG vaccinations in children, regardless of their Mantoux reading is fully acceptable, it is not known whether or not BCG vaccination of tuberculin reactors or the revaccination of children with BCG scars would confer any benefits (28).

In 1957, vaccination coverage was only 36.7% for the newborns. With increasing public confidence in the vaccine, BCG coverage continued to improve. By 1967, the annual coverage exceeded 90% of the live-births. In 1972, 90% of primary school children and 75% of secondary school students have been covered with BCG vaccinations.

With improvement in housing and other socio-economic conditions, the wide coverage of the BCG vaccination programme, and the availability of specific anti-tuberculosis drugs, TB morbidity and mortality decline markedly and childhood TB is no longer a problem (Fig. 4).

In 1958, a pulmonary TB case finding survey was undertaken in two urban and two rural areas. The survey was conducted in these four areas on all residents above 15 years of age on a voluntary basis. The prevalence rate was 23.5 per 1,000 population for active pulmonary TB and 7.5 per 1,000 for bacillary confirmed cases. A TB prevalence survey conducted in 1975 showed that compared with the situation in 1958, there was a 51.5% reduction of active pulmonary TB and a 38.7% reduction of bacillary cases. The case prevalence for the population aged 15 years and older was estimated to be 11.4 per 1,000 for active pulmonary TB, 32.5 per 1,000 for inactive pulmonary TB and 4.6 per 1,000 for bacillary positive pulmonary TB (29, 30). It has been demonstrated that the probability of developing TB is reduced three-and-a-half times with BCG vaccination (30).

Fig 4.

Incidence per 100,000 population from Tuberculosis and immunisation coverage rates, Singapore, 1957-1982.

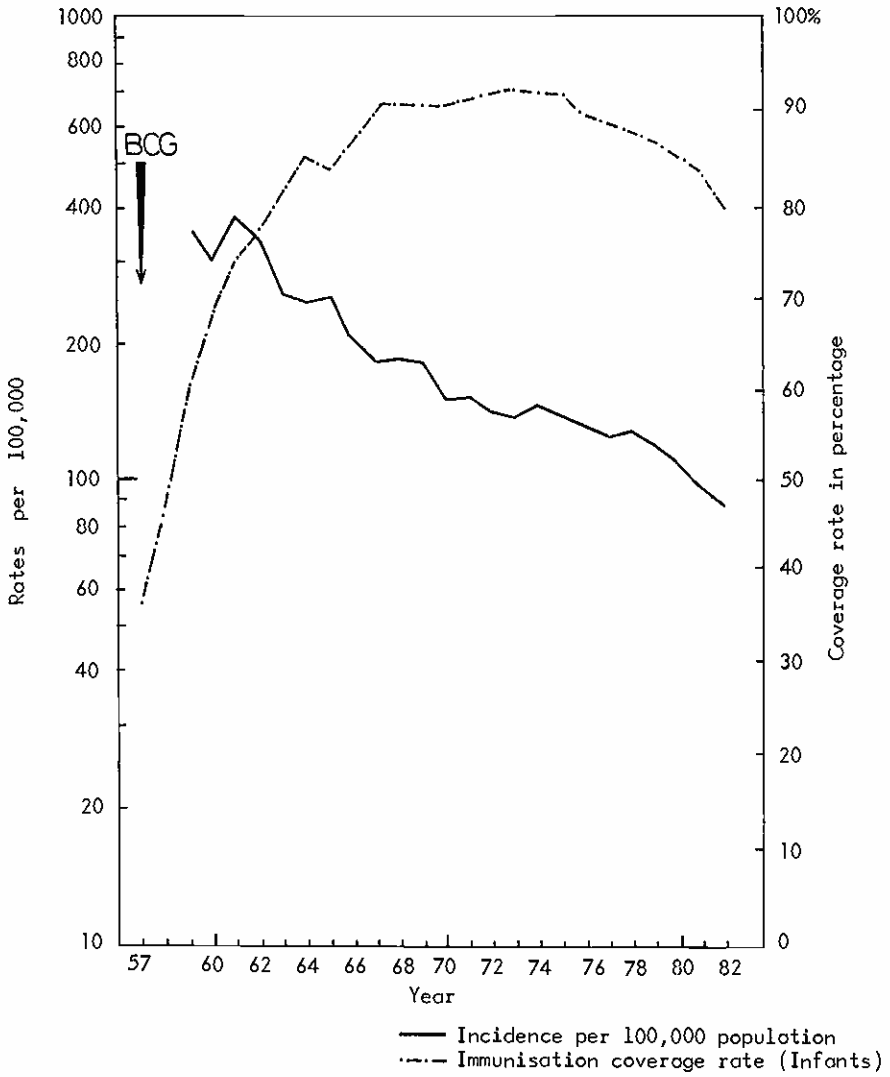
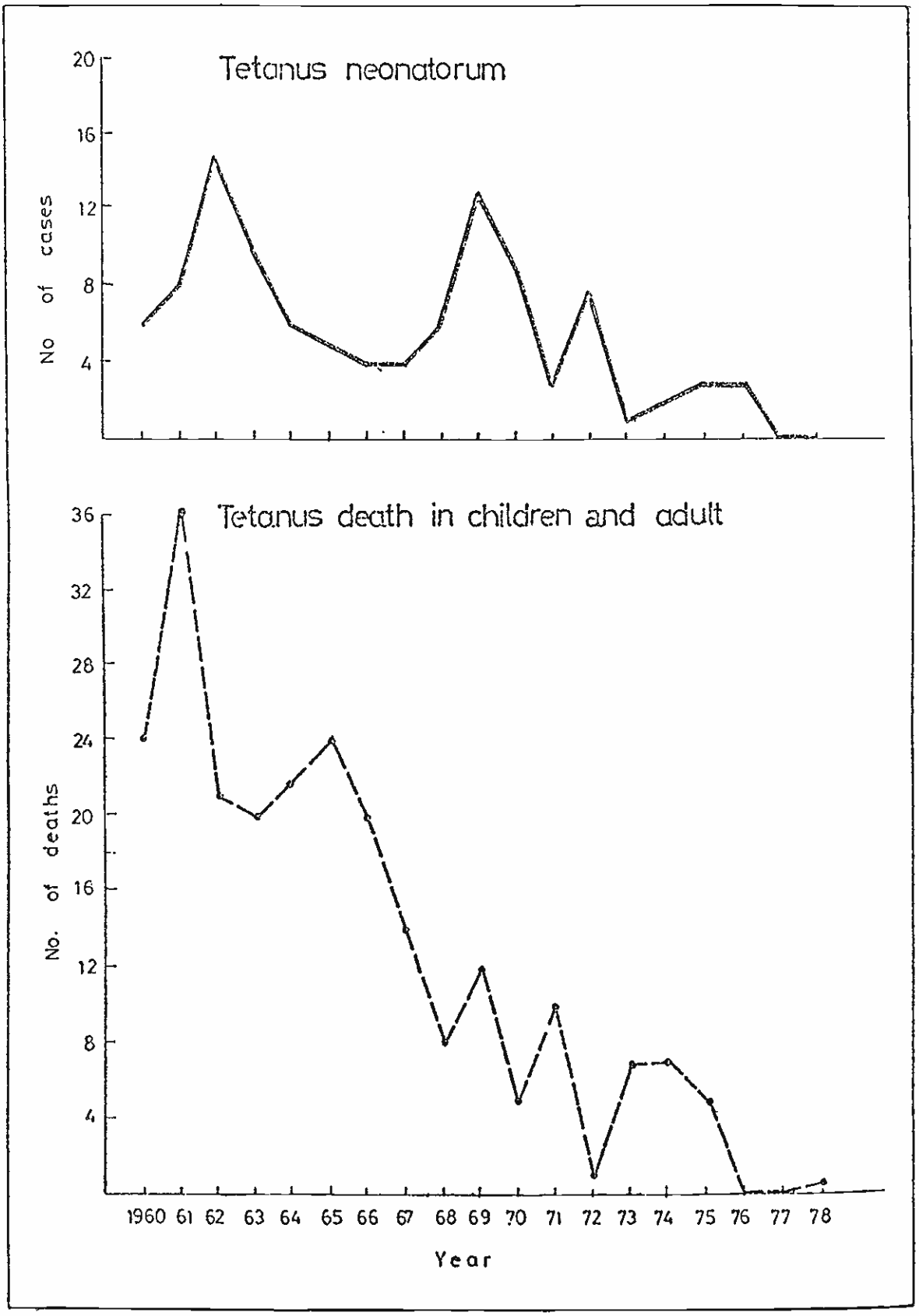


Fig 5.
Tetanus in Singapore, 1960-1978.



Based on: Wong H B. The impact of immunisation on childhood infections in Singapore. Proceedings XIV Singapore-Malaysia Congress of Medicine 1979; 47 - 58

MEASLES AND RUBELLA

Measles vaccination for infants after they have completed their primary immunisation course was also included in the national immunisation programmes in October 1976, while rubella immunisation for female primary school leavers (11 + years) started in November 1976.

The decision to include these two vaccines was based on the following considerations. Both vaccines have been introduced on a mass scale in developed countries, and have been found to be safe and efficacious (31 — 34). In Singapore, there were 600 hospital admissions and 11 deaths attributed to measles in 1973. This probably represented only a fraction of the total disease incidence in the country. It was estimated that it cost the country $170,917.40 for the hospital stay of these patients alone. The cost of vaccines for a mass immunisation programme, on the other hand, cost $125,000 annually. In the case of rubella, the incidence of congenital rubella was 8.5 per 100,000 deliveries at Kandang Kerbau Maternity Hospital for the period November 1969 — December 1971 (35). A high proportion of them developed complications with the most serious being mental retardation. It was estimated that it would cost approximately $112,500 annually to vaccinate all girls leaving primary schools. The cost was considered negligible compared with the cost borne by the country in providing hospital and nursing care for those with complications arising from congenital rubella.

FORMULATION AND IMPLEMENTATION OF THE PROGRAMMES

The national immunisation programmes in Singapore are formulated and periodically reviewed by an Expert Committee on the Immunisation Programme, comprising medical specialists in paediatrics, microbiology, thoracic medicine, epidemiology and public health administration. The recommendations are then submitted to the Joint Coordinating Committee on Epidemic Diseases for endorsement before implementation. As for BCG vaccinations, the programme is also reviewed from time to time by the Singapore Tuberculosis Advisory Council.

The Immunisation programmes in Singapore prior to 1976 and for the period 1976 — 1981 are shown in Tables 2 and 3.

The programmes are implemented by the Maternal & Child Health Services (MCHS), School Health Services (SHS) and the Department of Tuberculosis Control (DTBC) of the Primary Health Care Division of the Ministry of Health. Medical practitioners in private practice also assist in the programmes.

Table 2 : Immunisation programmes in Singapore, 1972 — 1976

DISEASE	PRIMARY COURSE	BOOSTER DOSES			
	INFANCY (<1 YR)	PRESCHOOL (1-5 YRS)	PRIMARY SCHOOL (6-11 + YRS)	SECONDARY SCHOOL (12-15 + YRS)	PRE-UNIVERSITY (16-17 + YRS)
Tuberculosis	Birth BCG without Mantoux test		6 + yrs (School Entry) BCG for Mantoux-ve 11 + yrs (School Leavers) BCG for Mantoux-ve	15 + yrs (School (Leavers) BCG for Mantoux-ve	17 + yrs (School Leavers) BCG for Mantoux-ve
Smallpox	6 months Primary vaccination		6 + yrs (School Entry) First Booster		
Diphtheria Pertussis Tetanus	3 months DPT (Dose 1) 4 months DPT (Dose 2) 5 months DPT (Dose 3)	18 + months DT (Booster 1) 4 yrs DT (Booster 2)	6 + yrs (School Entry) DT (Booster 3)		
Poliomyelitis	3 months Dose 1(Type I + III) 4 months Dose 2 (Type I + III) 5 months Dose 3 (Type I, II + III)	18 + months Booster 1 (Type I,II + III) 4 yrs Booster 2 (Type I, II + III)	6 + yrs (School Entry) Booster 3 (Type I, II + III) Booster 4 (Type I, II + III)		

1. DT (Booster 3) not given to children who received vaccination < 2 yrs before school entry.
2. Polio Booster 3 and 4 not given to children who completed primary course < 1 yr before school entry.

TABLE 3 : Immunisation programmes in Singapore, 1976 – 1981

DISEASE	PRIMARY COURSE		BOOSTER DOSES		
	Infancy (<1 yr)	Pre-school (1-5 yrs)	Primary School (6-11 + yrs)	Secondary School (12-15 + yrs)	Pre-University (16-17 + yrs)
Tuberculosis	Birth-BCG without Mantoux test.		6 + years (Primary School entry). BCG for Mantoux non-reactors with no previous BCG vaccination. 11 + years (Primary School leavers) BCG for Mantoux non-reactors if : 1) no previous BCG vaccination; or 2) the previous vaccnation was given more than 10 years ago.	15-16 years (Secondary IV School leavers) BCG vaccination for Mantoux non-reactors if : 1) no previous BCG vaccination; or 2) only one previous vaccination at least one year ago.	17-19 years (Pre-U II School leavers). As for Secondary IV school leavers
Smallpox*	2 months. Primary vaccination		6 + years (School entry) 1st Booster		
Diphtheria Pertussis Tetanus	3 months DPT (1st Dose) 4 months DPT (2nd Dose) 5 months DPT (3rd Dose)	18 months DPT (1st Booster)	6 + years (School entry) DT (2nd Booster) 11 + years (School leavers) DT (3rd Booster)	15 + years (School leavers) DT (4th Booster)	17 + years (School leavers) DT (5th Booster)
Poliomyelitis	3 months (Types I + III) 4 months (Types I + III) 5 months (Types I, II + III)	18 months 1st Booster (Types I, II + III) 4 years + 2nd Booster (Types I, II + III)	6 + years (School Entry) Either (a) Primary course – for those who never had vaccine or (b) 3rd Booster (Types I, II + III) for those who had any vaccine 11 + years (School Leavers) 4th Booster (Types I, II + III)	15 + years (School leavers) 5th Booster (Types I, II + III)	
Measles		1 year 1 dose			
Rubella			11 + years (School leavers) 1 dose to girls only		

NB: When the recommended time schedule was not followed then the time interval between the different doses was adhered to.

*Routine smallpox vaccination of children not compulsory since 6 March 81.

Table 4 : Recommended immunisation programmes in Singapore, 1982

	PRIMARY COURSE	BOOSTER DOSES			
DISEASES	**Infancy (<1 yr)**	**Pre-School (1-5 yrs)**	**Primary School (6-11 + yrs)**	**Secondary School (12-15 + yrs)**	**Pre-University (16-17 + yrs)**
Tuberculosis	Birth — BCG without Mantoux test		6 + years (Primary School entrants) BCG for Mantoux non-reactors with no previous BCG vaccination 11 + years (Primary School leavers) BCG for Mantoux non-reactors if: (1) no previous BCG vaccination; or (2) the previous vaccination was given more than 10 years ago.	15-16 years (Secondary IV School leavers) BCG vaccination for Mantoux non-reactors if : (1) no previous BCG vaccination; or (2) only one previous vaccination at least one year ago.	17-19 years (Pre-U II School leavers) As for Secondary IV School leavers
Diphtheria* Pertussis Tetanus	3 months DPT (1st Dose) 4 months DPT (2nd Dose) 5 months DPT (3rd Dose)	18 months DPT (1st Booster)	6 + years (Primary School entrants) DT (2nd Booster) 11 + years (Primary School leavers) DT (3rd Booster)		
Poliomyelitis*	3 months (Types I, II + III) 4 months (Types I, II + III) 5 months (Types I, II + III)	18 months 1st Booster (Types I, II + III)	6 + years (Primary School entrants) Either (a) Primary course - for those who never had vaccine or (b) 2nd Booster (Types I, II + III) for those who had any vaccine 11 + years (Primary School leavers) 3rd Booster (Types I, II + III)		
Measles		1 year 1 dose			
Rubella			11 + years (Primary School leavers) 1 dose for boys and girls		

*NB : When the recommended time schedule is not followed then the time interval between the different doses should be adhered to. Interrupting the recommended schedule or delaying subsequent doses does not reduce the ultimate immunity. There is no need to restart a series regardless of the time elapsed between doses. However, to help ensure seroconversion, completion of the primary series of three doses is recommended.

For the vaccination of infants and pre-school children, the target population is based on notifications of birth obtained from (a) duplicate copies of the 24-hour Notification of Birth Forms received from private medical practitioners and midwives and (b) Preliminary Report of Birth Forms received from the Registrar of Births and Deaths. Notification of all diptheria vaccination procedures is compulsory. For pre-school children, duplicate copies of vaccination certificates issued by medical practitioners in private practice and at MCHS clinics are routinely sent to the Central Immunisation Registry, Ministry of Health, where the records are computerised. Follow-up home visits are made to cover missed vaccinees and defaulters.

REVISION OF THE IMMUNISATION PROGRAMMES

Annual evaluation of the programmes is carried out by the Quarantine & Epidemiology Department, Ministry of the Environment. Based on the findings, two major revisions of the programme were made by the Expert Committee on the Immunisation Programme; one in 1975 and the other in 1982.

In the first comprehensive review of the immunisation programmes in 1975, the Expert Committee recommended that primary school leavers (11 + years) need not be Mantoux tested before BCG vaccination. It was also felt that BCG vaccination of primary school leavers would cover all the 11 + years age group in Singapore, since almost all children in Singapore go the primary school. This would protect the 11 + years age group and make further BCG vaccinations for the Mantoux negatives of secondary school (15 + years) and pre-university school (17 + years) leavers unnecessary. However, as a subsequent study carried out by the DTBC showed that indiscriminate BCG vaccination might lead to a relatively large proportion of school children developing post-vaccination keloids, the recommendation was not implemented.

For DPT, it was noted that when the first booster against pertussis for pre-school children (18 + months) was discontinued in May 1974, there was an increase in clinical whooping cough. Therefore, DPT instead of DT was recommended for the first booster at 18 + months. The second booster given to pre-school children at 4 + years was considered redundant because (i) the risk of pre-school children contracting diphtheria or pertussis was low due to the almost universal coverage of primary vaccination for all live-births and the generally low incidence of the diseases in the country; (ii) the children who received the second booster late would miss the booster given at school entry and would probably not be vaccinated further; and (iii) the population coverage for the second booster was low when compared with the coverage for both the primary course and the booster given at school entry. It was also considered necessary to extend DT boosters to primary (11 + years), secondary (15 + years) and pre-university (17 + years) school leavers. This was specifically aimed at the protection of children against tetanus. It was decided to use DT toxoid and not just tetanus toxoid alone since the cost of both types of toxoid was the same.

As for poliomyelitis, the vaccination programme for primary school entrants (6 + years) was simplified. These children were divided into two categories — those who had never received any poliovirus vaccine and those who had previously received poliovirus vaccine, irrespective of the number of doses received. For the first category, they would be given a primary course of three doses similar to that administered at infancy; and for the other category, only a booster dose comprising poliovirus types 1, 2 and 3 would be necessary. The programme was also extended to primary (11 + years) and secondary school (15 + years) leavers.

It was during this comprehensive review in 1975 that measles and rubella vaccinations were recommended for inclusion in the national immunisation programmes.

Minor amendments to the immunisation programmes were made between 1977 and 1981. Measles vaccine was administered to pre-school children at the age of 12 months instead of nine months as from 1 October 1977. However, in a situation where there is a likelihood of exposure, a child may be immunised between six and 12 months of age, but it would be necessary to recall the child for a booster after the age of one year to ensure solid and lasting immunity. In 1981, the first two doses of bivalent poliovirus vaccine given to infants were substituted by the trivalent vaccine.

In 1982, at the request of the Joint Coordinating Committee on Epidemic Diseases, the Expert Committee on the Immunisation Programme specifically reviewed the need to have large numbers of booster doses for protection against tetanus, diphtheria and poliomyelitis. In the review, the Committee studied in details the immunisation schedules of the developed countries; namely USA, UK, Canada, Australia, Japan, the Netherlands and Poland (36 — 45). The efficacy of the immunisation programmes in eradicating vaccine-preventable diseases in these countries was also considered.

In Singapore, five boosters of tetanus and diphtheria are given, whereas in the developed countries, only two to three boosters are given. In these countries, tetanus has occurred almost exclusively in persons who were unimmunised or whose immunisation history was unknown. Available evidence indicates that tetanus toxoid is highly effective and generally induces protective levels of serum antitoxin which persists for ten years or more after full immunisation. Unlike other communicable diseases where herd immunity reduces the risk of infection among the unimmunised, prevention of tetanus can only be achieved by individual immunisation. Eradication of the disease requires immunisation of the total population. As for diphtheria, most cases (both in children and adults) in developed countries occurred in unimmunised or inadequately immunised persons. Adequate immunisation is believed to protect for at least ten years. It significantly reduces both the risk of developing diphtheria and the severity of clinical illness. Although immunisation against diphtheria provides protection from diphtheria toxin, it has little effect on the organisms *per se*. Immunised persons can still carry and transmit diphtheria from asymptomatic sites such as the pharynx or from cutaneous or aural infections, and pose a continuing threat to susceptibles in the population. Serological studies of diphtheria immunity in different age groups carried out in Poland where diphtheria immunisation was introduced in 1954 showed that infants and children below 15 years of age are protected against the disease. Immunity in younger age groups has been induced by immunisation while older persons could have acquired natural immunity. Between these two groups, there are young adults 20 years to 30 years of age who are less protected against diphtheria.

In Singapore, five booster doses of poliovirus vaccine are given for protection against the disease. In other developed countries, only one to three booster doses are given. Full primary vaccination with oral poliovirus virus vaccine is believed to produce long-lasting immunity to all three poliovirus types in more than 95% of recipients. One booster dose is given to increase the likelihood of complete immunity on the small percentage of those who have not previously developed serum antibodies to all three types of poliovirus. The need for supplementary boosters has not been established. In developed countries, inapparent infection with wild strains no longer contributes significantly to establishing or maintaining immunity, making universal vaccination of infants and children even more important. In 1978, epidemics of poliomyelitis were reported in the Netherlands, Canada and the USA in communities where there was strong objections to immunisation on religious grounds. None of those ill had ever been immunised against poliomyelitis.

The rubella vaccination programme was also reviewed. In Singapore, the policy on rubella vaccination is similar to

that in the UK; ie. inoculation of girls at 11 + years of age. It was hoped that the vaccine would supplement natural infection so that between 80 and 90% of individuals would be immune by the time they start to have families. This differs from the American policy where it was hoped that mass vaccination of all children would reduce the amount of circulating viruses and thus eliminate adult infection.

In contrast with the experience of Western countries where 80 – 90% of women have acquired immunity to rubella by the time they reach the reproductive age group, between 44% and 51% of women in the child-bearing age in Singapore are susceptible to rubella (46). All previous rubella epidemics in Singapore started among national servicemen but soon spread from the army camps to the rest of the population. As the virus was believed to have been introduced into Singapore by soldiers returning from overseas training, all national servicemen are routinely vaccinated against rubella when they are sent overseas. Periodic outbreaks of rubella in army camps also affected the training schedules of national servicemen through sickness-absenteeism. Of far more importance is that these soldiers infected with rubella served as the source of infection to other susceptible females in the reproductive age group at homes and in public areas.

The Committee recommended that the fourth and fifth DT booster doses given at 15 + years and 17 + years respectively be deleted from the existing immunisation programmes. (It was decided to retain the booster at 11 + years instead of 15 + years because of the marked decrease in school population at the latter age group. In 1980, there were 40, 563 primary VI school leavers compared with 28,913 at Secondary IV). As for poliomyelitis, it was recommended that the second and fifth booster doses given at 4 + years and 15 + years be deleted. The Committee also recommended that rubella vaccines be administered to both boys and girls at 11 + years of age. (This is aimed at the prevention of rubella outbreaks in army camps in future).

The revised National Immunisation Programme for 1982 as recommended by the Committee is shown in Table 4.

The Ministry of Health has accepted all the recommendations and has implemented the revised programmes as from 1 April 1982. Rubella vaccination for boys will be reviewed again, because by the year 1986, the cohort comprising girls who were previously vaccinated against rubella in 1976 would have reached 21 + years of age.

The Ministry of Defence (MINDEF) will routinely administer a booster dose of tetanus, diphtheria and poliovirus vaccines to all national service recruits as from 1988. This would ensure that all national servicemen are adequately protected against these diseases. As from 1982, all recruits were also vaccinated against rubella to reduce loss in training time as a result of frequent outbreaks of rubella. Rubella vaccination for national service boys will be reviewed in 1988, as by that time, all boys who enter national service would have been immunised at 11 + years of age in schools.

To prevent over-immunisation against tetanus, the Ministry of Health has instructed all Government medical doctors not to routinely give tetanus toxiods to Singapore residents who sustain any injury, unless they have no previous history of tetanus vaccination or the toxoid was given more than ten years ago. Tetanus boosters are only indicated once every ten years. The Health Ministry has also decided to adopt the system of recording all immunisation procedures carried out from infancy to school leaving age in a health information booklet. Vaccinations carried out by General Practitioners (GPs) will also be included. This record would then be sent over to MINDEF for updating.

All GPs in Singapore were also advised to adopt the revised immunisation programmes.

IMMUNISATION COVERAGE FOR THE PERIOD 1978-1982

SMALLPOX

1980 was the last full year when smallpox vaccination was compulsory by law. The coverage of infants below one year of age vaccinated between the years 1977 and 1980 was estimated to range from 88.9% (in 1980) to 99.0% (in 1977) of the total live-births. All new school entrants (6 + years) were revaccinated or vaccinated against smallpox except those who had been vaccinated less than three years before school entry or those who had some medical contraindications. An estimated 95.6% of primary I entrants were vaccinated.

DIPHTHERIA/PERTUSSIS/TETANUS

During the period 1978 — 1982, 85.3% of the total live-births completed the primary course of immunisation before one year of age, while a total of 35,857 booster doses were administered to pre-school children. For school children, a primary course of two doses of DT vaccines was given to primary I school entrants who had never been immunised and a single dose of DT vaccine was given to those who never received a booster dose or who received a booster dose more than two years prior to school entry. Of the primary I school children, 95.2% were vaccinated; only 0.9% required a primary course (Table 5). In addition, 94.6% of primary VI (11 + years), 94.3% of secondary IV (15 + years) and 81.9% of pre-university II (17 + years) school leavers were given booster doses of DT between the years 1978 and 1982 (Table 6).

POLIOMYELITIS

During the period 1978 — 1982, 84.0% of the total live-births completed the primary course of immunisation under one year of age, while an estimated 74.1% — 86.5% of pre-school children were given the first booster doses. For the same period, booster doses were administered to 93.8% of primary school entrants (Table 7). Subsequent boosters were given to 88.5% of the primary VI and 91.4% of secondary IV school leavers between the years 1978 and 1982 (Table 8).

TUBERCULOSIS (47)

Amongst infants born in Government hospitals, 82.9% were vaccinated prior to discharge from the wards. Of the infants born outside Government hospitals, 16.0% were vaccinated by MCHS. The overall coverage was 84.3% of the total live-births. This did not include vaccinations carried out by private medical practitioners (Table 9).

Other than in infancy, BCG vaccination was always preceded by a Mantoux test. Children who missed their primary BCG vaccinations and remained tuberculin non-reacting (Mantoux $\prec$ 10 mm) at primary I school entry were vaccinated. During the five-year period from 1978 to 1982, 1877 primary I school children forming 0.8% of the enrolment were vaccinated. At primary VI, secondary IV and pre-university II classes, children were again routinely Mantoux tested, and BCG vaccinations administered to all non-reactors. In the case where a child had had two previous vaccinations, no third dose was given. The precentages of these older children vaccinated during this period were 69.5% of the enrolment in primary VI, 4.1% in secondary IV and 2.2% in pre-university II classes (Table 10).

Annual examination of school children revealed that there has been a progressive increase of BCG-vaccinated children. The proportion of Primary I school children with BCG-vaccination scars ranged from 97.9% to 99.0%. The corresponding figures for primary VI, secondary IV and pre-university II were 94.9% — 96.8%, 95.6% — 98.1% and 95.9% — 98.8% respectively (Table 11).

MEASLES

The response to measles vaccination was slow, as the local population prefer to have their children developed natural measles infection (48). The total number of children

TABLE 5 : DIPHTHERIA/PERTUSSIS/TETANUS IMMUNISATION OF PRE-SCHOOL AND SCHOOL CHILDREN, 1978 – 1982

YEAR	NO. OF LIVE BIRTHS@	VACCINATION OF PRE-SCHOOL CHILDREN				VACCINATION OF SCHOOL CHILDREN (6+ YEARS)			
		NO. COMPLETED PRIMARY COURSE BEFORE 1 YEAR OF AGE (% LIVE-BIRTHS IMMUNISED)	NO. COMPLETED PRIMARY COURSE (DPT)	NO. OF BOOSTERS GIVEN	ESTIMATED % OF PRE-SCHOOL CHILDREN GIVEN BOOSTER DOSES	NO. OF SCHOOL ENTRANTS	NO. RECEIVED PRIMARY IMMUNISATION (% OF SCHOOL ENTRANTS GIVEN PRIMARY VACCINATION	NO. OF BOOSTERS GIVEN*	NO. GIVEN A BOOSTER OF PRIMARY COURSE (% OF SCHOOL ENTRANTS IMMUNISED)
1979	39,441	33,940 (86.1)	35,814	36,125	84.4	44,967	508 (1.1)	42,114	42,622 (94.8)
1979	40,847	35,501 (86.9)	37,219	36,247	94.5	46,438	392 (0.8)	44,553	44,945 (96.8)
1980	41,217	34,660 (84.1)	36,266	36,015	91.3	46,232	367 (0.9)	43,545	43,932 (95.0)
1981	42,250	36,706 (86.9)	38,179	35,145	86.0	42,320	352 (0.8)	40,670	41,022 (96.9)
1982	42,391	35,127 (82.9)	36,185	35,754	86.7	39,347	258 (0.7)	35,933	36,191 (92.0)
MEAN	41,229	35,187 (85.2)	36,733	35,857	–	43,861	379 (0.9)	41,363	41,474 (95.2)

*Figures include : (i) Those given a booster dose at school entry; and

(ii) Those given a booster dose less than two years before school entry.

@ Source: Department of Statistics, Singapore.

TABLE 6 : DIPHTHERIA AND TETANUS BOOSTERS GIVEN TO SCHOOL CHILDREN 11 + YEARS AND ABOVE, 1978 – 1982

YEAR	11 + YEARS (PRIMARY VI)			15+ YEARS (SECONDARY IV)			16-17+ YEARS (PRE-U II)		
	TOTAL NO. OF STUDENTS	NO. OF BOOSTERS GIVEN	% OF STUDENTS COVERED	TOTAL NO. OF STUDENTS	NO. OF BOOSTERS GIVEN	% OF STUDENTS COVERED	TOTAL NO. OF STUDENTS	NO. OF BOOSTERS GIVEN	% OF STUDENTS COVERED
1978	43,716	41,770	95.6	33,179	33,133	99.9	7,951	6,348	79.0
1979	42,953	40,419	94.1	33,873	31,234	92.2	8,836	7,409	83.9
1980	40,563	38,349	94.5	28,913	27,049	93.6	6,352	5,199	81.8
1981	36,658	36,175	98.7	28,643	26,080	91.1	7,761	6,365	82.0
1982	54,069	49,389	91.3	–	–	–	–	–	–
MEAN	43,592	41,220	94.6	31,152	29,374	94.3	7,725	6,330	81.9

Boosters for Secondary IV and Pre-U II students discontinued in 1982.

TABLE 7 : POLIOMYELITIS IMMUNISATION IN SINGAPORE CHILDREN, 1978 – 1982

YEAR	NO. OF LIVE BIRTHS@	VACCINATION OF PRE-SCHOOL CHILDREN				VACCINATION OF SCHOOL CHILDREN (6+ YEARS)			
		NO. COMPLETED PRIMARY COURSE BEFORE 1 YEAR OF AGE (% LIVE-BIRTHS IMMUNISED)	NO. COMPLETED PRIMARY COURSE	NO. OF BOOSTERS GIVEN	ESTIMATED % OF PRE-SCHOOL CHILDREN GIVEN BOOSTER DOSES	NO. OF SCHOOL ENTRANTS	NO. RECEIVED PRIMARY IMMUNISATION (% OF SCHOOL ENTRANTS GIVEN PRIMARY IMMUNISATION)	NO. OF BOOSTERS GIVEN	NO. GIVEN A BOOSTER OR PRIMARY COURSE (% OF SCHOOL ENTRANTS IMMUNISED)
1978	39,441	32,761 (83.1)	34,909	65,885	76.6	44,967	624 (1.4)	41,827	42,451 (94.4)
1979	40,847	34,146 (83.6)	36,226	62,171	79.1	46,438	485 (1.0)	43,849	44,334 (95.5)
1980	41,217	34,228 (83.0)	36,137	60,947	74.1	46,332	427 (0.9)	42,736	43,162 (93.4)
1981	42,250	36,695 (88.2)	38,444	61,231	77.3	42,320	418 (0.9)	40,157	43,162 (93.4)
1982	42,391	35,304 (82.8)	36,577	35,647+	86.5	39,347	296 (0.8)	34,911	35,207 (89.5)
MEAN	41,229	34,627 (84.0)	36,459	–	–	43,861	450 (1.0)	40,696	41,146 (93.8)

+One booster given at 18 months only.

@Source : Department of Statistics, Singapore.

TABLE 8 : POLIOMYELITIS BOOSTERS GIVEN TO SCHOOL CHILDREN

YEARS	11 + YEARS STUDENTS (PRIMARY VI)			15 + YEARS STUDENTS (SECONDARY IV)		
	TOTAL NO. OF STUDENTS	NO. OF BOOSTERS GIVEN	% OF STUDENTS VACCINATED	TOTAL NO. OF STUDENTS	NO. OF BOOSTERS GIVEN	% OF STUDENTS VACCINATED
1978	43,716	37,388	85.5	33,179	30,152	90.0
1979	42,953	37,294	86.8	33,875	31,109	91.8
1980	40,563	34,753	85.7	28,913	26,381	91.2
1981	36,658	34,962	95.3	28,643	26,253	91.7
1982	54,069	48,505	89.7	—	—	—
MEAN	43,592	38,580	88.5	31,153	28,474	91.4

Boosters for Secondary IV students discontinued in 1982.

TABLE 9 : BCG VACCINATIONS GIVEN TO INFANTS BY MINISTRY OF HEALTH BY PLACE OF BIRTH, 1978 – 1980*

PLACE OF BIRTH	VACCINATIONS GIVEN IN GOVERNMENT HOSPITALS					VACCINATIONS GIVEN IN MCHC				VACCINATIONS GIVEN BY MINISTRY OF HEALTH	
YEAR	Kandang Kerbau Hospital	Toa Payoh Hospital	Alexandra Hospital	Sub Total	% Covered	Born in Government Hospitals	Born Outside Government Hospitals	Sub-Total	% covered	TOTAL	% covered
1978											
Live-births	22759	5286	5183	33228		33228	6213	39441		39441	
vaccinated	20230	4015	3984	28229	85.0	4681	1508	6189	15.7	34418	87.3
1979											
Live-births	23717	5599	5313	34629		34629	6150	40779		40779	
vaccinated	19939	4406	4251	28596	82.6	5399	1261	6660	16.3	35256	86.5
1980											
Live-births	22354	5941	6031	34326		34326	6996	41322		41217	
vaccinated	18384	4529	4899	27812	81.0	5863	1241	7124	17.2	34936	84.8
1981											
Live-births	23157	5382	5638	34177		34177	8116	42293		42250	
vaccinated	19524	4098	4421	28043	82.1	5875	1259	7134	16.9	35177	83.2
1982											
Live-births	23771	4852	5053	33676		33676	8978	42654		42654	
vaccinated	20653	3802	3815	28270	84.0	4795	1068	5863	13.7	34133	80.0
1978-1982											
Live-births	115758	27060	27218	170036		170036	36453	206489		206341	
vaccinated	98730	20850	21370	140950	82.9	26633	6337	32970	16.0	173920	84.3

*Source : Singapore Tuberculosis Statistics 1982, Department of Tuberculosis Control, Primary Health Care and Health Education Division, Ministry of Health.

TABLE 10 : BCG VACCINATIONS GIVEN BY MINISTRY OF HEALTH AND BY SINGAPORE ANTI-TUBERCULOSIS ASSOCIATION (SATA), 1978 TO 1982*

YEAR	1978		1979		1980		1981		1982		1978 – 1982	
TARGET POPULATION	Number	% vaccinated	Number	% vaccinated	Number	% vaccinated	Number	% vaccinated	Number	% vaccinated	Number	% vaccinated
Live-births	39441		40779		41217		42250		42654		206341	
vaccinated	34418	87.3	35256	86.5	34936	84.8	35177	83.3	34133	80.0	173920	84.3
Primary I	45267		47678		46650		42254		39347		221196	
vaccinated	605	1.3	457	1.0	337	0.7	381	0.9	97	0.3	1877	0.8
Primary VI	44269		43426		41038		37292		54069		216094	
vaccinated	28668	64.8	27483	63.3	25959	63.3	26371	70.7	41687	77.1	150168	69.5
Secondary IV	39419		39716		34180		33002		49232		195549	
vaccinated	1263	3.2	1390	3.5	1033	3.0	1938	5.9	2374	4.8	7998	4.1
Pre-U II	8262		8119		6609		8410		7036		38436	
vaccinated	116	1.4	60	0.7	65	1.0	157	1.9	444	6.3	842	2.2
Others (including those vaccinated by SATA)	1462		1630		1605		1217		1008		6922	
TOTAL	66532		66276		63935		65241		79743		341727	

*Source : Singapore Tuberculosis Statistics 1982, Depart of Tuberculosis Control, Primary Health Care and Health Education Division, Ministry of Health.

TABLE 11 : PERCENTAGE WITH BCG SCAR FOUND ON ROUTINE EXAMINATION OF SCHOOL CHILDREN PRIOR TO ANNUAL TUBERCULIN TESTING AND BCG VACCINATION, 1978 – 1982*

SCHOOL	1978		1979		1980		1981		1982	
GRADES	No. examined	% with scar	No. examined	% with scar	No. examined	% with scar	No. examined	% with scar	No. examined	% with scar
Primary I	452687	98.3	44678	98.6	46650	99.0	42254	98.6	38534	97.9
Primary VI	42141	95.4	41669	94.6	39331	96.3	35863	96.8	51038	96.8
Secondary IV	35082	96.0	35874	95.6	31153	96.8	30248	97.7	30491	98.1
Pre-U II	6594	95.9	6754	96.2	558	96.3	5885	97.7	5761	98.8

*Source : Singapore Tuberculosis Statistics 1982, Depart of Tuberculosis Control, Primary Health Care and Health Education Division, Ministry of Health.

vaccinated has been gradually increasing. This was the result of intensive health education campaigns and the checking of measles vaccination certificates for all registrants to the 1982 pre-primary and primary I classes. The acceptance rate in 1982 showed an increase of 36.6% over that of 1981 and 70.5% that of 1980 (Table 12). In 1982, a total of 33,110 vaccinations were performed.

RUBELLA

Rubella vaccination for girls 11 + years of age has been very encouraging. During the period 1978 — 1982, 94.7% — 97.1% of the female primary VI school leavers were vaccinated (Table 13).

DIPHTHERIA

The last diphtheria case involved an unimmunised six-year-old girl living in Bukit Panjang. She was ill on 21 September 1974 and as she had been previously treated with antibiotics, no diptheria organisms could be cultured. She was clinically diagnosed as a case of diptheria based on typical appearance of the throat and ECG changes. Between May 1977 and June 81, two diphtheria carriers (one aural and the other pharyngeal) were reported in two children who had been fully immunised against the disease.

In 1982, indigenous diphtheria reappeared in four unimmunised children. The cases were a four-year-old girl at Redhill, a two-year-old boy and his four-year-old brother at Lim Chu Kang and a three-year-old girl at Bedok. The two-year-old boy at Lim Chu Kang developed fever, cough and sore throat on 15 July. He was seen by three GPs and subsequently admitted to Alexandra Hospital on 22 July in a serious condition. He was clinically diagnosed as diphtheria with cardiac complications. He died of myocarditis on 2 August. During epidemiological investigations, his elder brother was found to have an infected throat with some white patches. *Corynebacterium diphtheriae* were cultured from the throat swab.

TABLE 12 : MEASLES IMMUNISATION, 1978 — 1982

	1978			1979			1980*			1981*			1982*		
	<1 yr	1 yr	TOTAL	<1 yr	1 yr	TOTAL	<1 yr	1 yr	TOTAL	<1 yr	1 yr	TOTAL	<1 yr	1 yr	TOTAL
MCH Clinics	40	9,168	9,208	19	9,958	9,977	0	18,018	18,018	0	22,232	22,232	0	29,950	29,950
Private Practi-tioners	104	458	562	108	622	730	138	1,268	1,406	115	1,891	2,006	121	3,039	3,160
TOTAL	144	9,626	9,770	127	10,580	10,707	138	19,286	19,424	115	24,123	24,238	121	32,989	33,110

*Measles vaccines given to children at one year of age and above as from 1980.

TABLE 13 : RUBELLA IMMUNISATION FOR PRIMARY VI SCHOOL CHILDREN, 1978 — 1982

YEAR	TOTAL ENROLMENT	TOTAL NO. OF VACCINATIONS GIVEN	% VACCINATED
1978	22,115	20,947	94.7
1979	21,575	20,970	97.1
1980	20,030	19,387	96.8
1981	18,341	17,709	96.6
1982 +	54,069	51,257	94.8

+ Given to both girls and boys as from 1982.

EFFICACY OF THE IMMUNISATION PROGRAMME

Of the vaccine-preventable diseases covered in the programmes, only smallpox, diphtheria, poliomyelitis and tuberculosis are legally notifiable. Measles was made administratively notifiable as from 1 October 1980. Steps have also been taken to assess the efficacy of the rubella immunisation programme by monitoring congenital rubella syndrome, the immune status of females in the reproductive age group and abortions carried out on account of rubella.

Indigenous smallpox was last reported in 1959, pharyngeal diphtheria in 1974 and paralytic poliomyelitis in 1978.

POLIOMYELITIS

On 19 June 1978, a case of paralytic poliomyelitis involving an eight-month-old Indian boy was notified. The baby was given the first dose of Sabin vaccine (types 1 and 3) on 4 May 1978, and developed paralysis of the left upper limb 16 days later. Poliovirus type 1 was isolated, but there was no four-fold rise in antibody titres. It was also found that another five-month-old Chinese baby developed paralysis of the left lower limb one week after receiving the first dose of Sabin vaccine. Poliovirus type 3 was isolated from stool cultures. No four-fold increase in antibody titres was again noted. As oral polio virus vaccine was administered, vaccine-derived viruses could continue to be excreted for months. The isolation of poliovirus from stool cultures does not necessary mean that paralysis was caused by the viruses ingested. Moreover, since types 1 and 3 strains were administered together, one would expect to recover both strains from stool cultures and not either one of them. As no attempts were made to distinguish vaccine-derived poliovirus from the wild strain, the significance of the findings remains unknown. It could not be concluded that these cases were vaccine-associated, a phenomenon that has been reported in the US (49).

TUBERCULOSIS

Tuberculous meningitis was eliminated from children below five years of age in 1978. These was a lower incidence of bacteriologically confirmed and unconfirmed pulmonary tuberculosis among the vaccinated as compared with the unvaccinated population (30). The future trend of tuberculosis incidence in Singapore has been projected based on an epidemiological model developed for the disease. The model leads to the conclusion that the most effective strategy to hasten the reduction of tuberculosis problem is to intensify case finding and treatment of bacillary cases, and that the BCG vaccination programme forms a second line of defence (50).

The efficacy of the immunisation programmes for prevention of diphtheria, poliomyelitis and tuberculosis is illustrated in Figs. 1, 3 and 4.

PERTUSSIS AND TETANUS

Although pertussis and tetanus are not notifiable, information obtained from various sources (51 — 56) showed that with better maternal and child health services, the incidence of pertussis and of neonatal tetanus has been drastically reduced and these diseases have virtually disappeared. An average of six admissions for pertussis were reported annually at Middleton Hospial during the period 1973 — 1982. All these sporadic cases were clinically diagnosed and not confirmed by the isolation of *Bordetella pertussis*. In the case of neonatal tetanus, in 1914, there were 225 reported cases out of 7,420 births. There was an annual average of 34.8 cases of neonatal tetanus between the years 1946 and 1950 (52), compared with 7.8 cases for the period 1965 — 1970 (55). During the five-year period 1970 — 1974, the Department of Pathology reported 24 deaths attributed to tetanus; nine of them were neonates less than one month old, while the others were all above 19 years of age. The incidence of tetanus neonatorum and of tetanus deaths for the period 1960 — 1978 (57) is shown in Fig. 5.

MEASLES AND RUBELLA

The impact of the immunisation programmes against measles and rubella have not been felt yet. Measles continues to show periodic sharp increases in incidence every few years. This epidemic cycle will disappear with increased coverage and the disease can be eliminated in the same way as the other vaccine-preventable childhood diseases if about 95% of each year's cohort of children are immunised at an average age of two years. This level of immunisation coverage is much higher than that of poliomyelitis and diphtheria, as vaccination of between 80% and 85% of the childhood population has virtually eliminated these diseases. Based on surveillance data obtained during epidemiological investigations of institutional outbreaks in 1981 and 1982, measles vaccine efficacy was shown to be more than 98%, while the relative risk of contracting measles if unvaccinated and with no previous history of measles was 50 times greater than if vaccinated. The Ministry of Health has further stepped up its health education campaigns to publicise the benefits and safety of measles vaccination and to overcome the various cultural and traditional beliefs that measles is an innocuous and inevitable childhood infection. In view of the large number of outbreaks reported in institutions for pre-school children in 1982, children registering for admission to creches and kindergartens will also be required to show proofs of measles immunisations or natural measles infection.

Periodic outbreaks of rubella continue to recur after the 1969 epidemic in 1975 — 1976 and 1977 — 1978. The 1975 — 1976 outbreak was followed by a marked increase in congenital rubella. However, it is believed that the practice of termination of pregnancy during epidemics had resulted in a small number of congenital rubella seen after the 1977 — 1978 outbreak. The rubella vaccination programme has been extended to include females of the reproductive age groups. Rubella vaccines are routinely offered to newly married couples or those planning to have children, mothers who have just delivered their first babies in Government hospitals and nurses who have not been previously vaccinated.

In conclusion, it must be pointed out that besides the comprehensive immunisation programmes, other socio-economic developments also contributed to the successful control of the childhood vaccine-preventable diseases. The excellent immunisation coverage must be continued so that the immunity of the population so arduously acquired over the years may be maintained. As for measles and rubella, with further health education efforts and intensification of the measles immunisation programme for pre-school children and of the rubella vaccination campaigns for females of the reproductive age group, measles and congenital rubella are also expected to be brought under control in the near future.

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