

TRENDS IN PROPHYLACTIC DIPHTHERIA IMMUNIZATION IN JOHANNESBURG

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Effective diphtheria immunization consists of a primary course of injections followed by a reinforcement dose (booster) at a later date.^{1,3} It is generally agreed that the primary course should be given early in life, preferably at 3-6 months of age,^{1,4,9} and that the injections should be spaced with an interval of 4-8 weeks.^{1,6,8,9} There is a difference of opinion on the need for 2 or 3 injections^{1-3,6,9,16,21} but Scheibel *et al.*³ have shown that 2 doses of a potent, adsorbed antigen suffice to produce a satisfactory immunity, which in most individuals is of several years' duration. In a small proportion of the individuals, however, the antitoxin level will have fallen below the assumed protective level 1 year after the primary course² and, consequently, a booster is called for at this time. This will ensure an immunity lasting 8-9 years, possibly longer,¹⁰ which appears to be unrelated to the epidemiological environment.¹⁰ Thus it seems unnecessary to include further booster doses in a practical routine immunization programme.¹⁰ By this method of prophylactic immunization, diphtheria has been suppressed in many places^{1,4,11} and eradicated in some.^{12,13}

In South Africa we have failed to take full advantage of prophylactic diphtheria immunization. Here the disease has been endemic for many years^{5,14,15} and at least up to 1952 there were no signs of a decline in morbidity rate.¹¹ In 1955, at a time when the disease had become a rarity in many countries, 242 deaths from diphtheria were recorded in this country.¹⁶

As shown by notification rates, diphtheria is particularly frequent in Johannesburg with the highest incidence in its White population.¹¹ Studies in 1955^{17,18} showed that a considerable proportion of the White children had not been immunized, that the degree of prophylactic immunization was related to socio-economic standards, and that the trends in immunization were such that a rapid decline in morbidity could not be expected. Prophylactic work among the Bantu is organized by the City Health Department, but so far no figures have been published on which to assess the degree of immunity conferred upon this group. This is regrettable since the Bantu constitute the largest section of the population¹⁰ and since the disease

appears to take a particularly serious course in this race.^{11,20}

As diphtheria is still prevalent in Johannesburg we decided to examine critically the present system of administration of the prophylactic, to enable us to devise ways of intensifying preventive measures and thereby to bring about a decline in morbidity. This demands a knowledge of the population at risk, which one of us (V.B.) has assembled and will publish separately.¹⁹

MATERIAL AND METHODS

The data required for the present survey were collected from questionnaires asking for the following information: (1) suburb of domicile, (2) race, (3) child's first name, (4) date and year of birth, (5) previous clinical diphtheria, (6) number and dates of prophylactic injections against diphtheria, and (7) whether the prophylactic had been administered by a general practitioner or at the municipal clinic. To obtain maximum cooperation, the exact address and the family surname were left out of the questionnaires. Contact with the families was established through the health visitors employed by the Johannesburg Municipal Health Department who pay a routine visit to the home of every newborn child in the municipal area. On their visits to White, Asiatic and Coloured homes during the period October 1957 - April 1958 they filled in questionnaires on all siblings born after 31 December 1949. Difficulties in obtaining accurate information from the Bantu made it necessary to exclude this group from the survey.

It was expected that the sampling method used would yield information from a representative cross-section of the surveyed ethnic groups, provided the immunization histories of siblings were the same as those of single children, who admittedly are ignored. Duplication of observations was avoided by restricting the survey to a 7-months' period.

The criteria adopted to ascertain the individual's immunization status are, with 2 exceptions, identical to those previously described.¹⁸ Firstly, 15 children, 10 White and 5 Coloured, were considered to be non-immunized, since we were unable to find out whether they were immunized or not. Secondly, 55 White, 6 Asiatic and 14 Coloured children, who had received only 1 prophylactic injection more than 3 months before the questioning, were also allocated to the unimmunized group.

RESULTS

Of 5,024 questionnaires returned, 4,948 (98.5%) contain sufficient information to allow tabulation. Of these, 3,908 refer to White, 543 to Asiatic and 497 to Coloured children. For the sake of clarity these groups will be considered separately.

White Children

Based on the address, the questionnaires are divided according to their origin from 3 socio-economic classes: the above medium (A), the medium (M) and the under medium (U).¹⁹ While the distribution of returned questionnaires from A- and M-classes (Table I) is in agreement

TABLE I. NUMBER OF OBSERVATIONS IN WHITE SOCIO-ECONOMIC CLASSES COMPARED WITH NUMBER OF LIVE BIRTHS IN 1958¹⁹

Class	Observations		Live births, 1958	
	Number	Proportional distribution	Number	Proportional distribution
Under medium	2,599	66.5%	5,551	59.2%
Medium	1,076	27.5%	3,140	33.5%
Above medium	233	6.0%	670	7.2%
Total	3,908		9,361	

with the distribution of live births in the districts in 1958,¹⁹ there is an unexpected excess of about 666 observations in the U-class, equivalent to approximately 17.0% of the total number of observations in White children. This may be due to a different family pattern in the U-districts as compared to the M- and A-districts or to a difference in the seasonal distribution of births between the socio-economic groups.¹⁹ Hence, results based on calculations of the total material in the White group will be slightly in favour of the conditions prevailing in the U-class. On the other hand, we have no evidence to suggest that the material is not fully representative of the individual socio-economic classes as presented in Table II.

This shows that the percentage of children given the primary course of prophylactic (column 4) increases with socio-economic standard. On an average 38.3% of the U-class children born after 1949 were unprotected at the time of the survey as against less than 1% of the A-class children. The declining immunization rates in the younger children of the U- and M-classes are probably attributable to the local practice of giving the primary course at any time from birth to well beyond 5 years of age.¹⁸ Of greater prophylactic importance and statistically more valid than total immunization rates is the percentage of individuals immunized before their second birthday.¹⁸ This percentage is calculated from the questionnaires about children aged 2 years or more at the time of the survey (born before 1956) giving precise information of injection dates. The figures, presented in column 5, are corrected by proportional allocation of those children of the same age (77 in U-, 18 in M- and 4 in A-class) who were stated to be immunized but lacked particulars of time (column 6). It shows that just over half of the surveyed children in the U-class, the majority in the M-class and practically all in the A-class received their primary course before the third year of life. The percentages in the M- and U-districts vary slightly from year to year. There has not been a fall in early immunization in recent years, but although the latest figures appear to be slightly higher, it is doubtful whether this may be considered a true rise.

The administration of boosters is summarized in Table III which shows that the White children in Johannesburg seldom receive them. The booster rate is related to socio-economic standard, being higher in the wealthier classes.

In Johannesburg the prophylactic injections are given either by general practitioners or at the municipal clinics. The distribution of the work is calculated from the questionnaires with section 7 completed (Table IV). The discrepancy between 'total number of immunized children' (Table II) and the number tabulated under place of immunization (Table IV) may be attributed to some extent

TABLE II. PRIMARY COURSE OF DIPHTHERIA IMMUNIZATION IN WHITE SOCIO-ECONOMIC CLASSES

Class	Year of birth	Observations	Immunized		Immunized under 2 years of age		
			Number	%	Number	Corrected number	% of observations
Under medium	1950	218	167	76.6	104	112	51.4
	1951	262	184	70.2	128	134	51.2
	1952	337	223	66.2	160	171	50.7
	1953	365	234	64.1	175	188	51.5
	1954	413	271	65.6	229	238	57.6
	1955	476	276	58.0	261	272	57.1
	1956	476	228	47.9			
	1957	52	21	40.4			
	Total	2,599	1,604	61.7			
Medium	1950	76	74	97.4	64	64	84.2
	1951	94	84	89.4	78	80	85.1
	1952	144	129	89.6	123	126	87.5
	1953	145	132	91.0	124	127	87.6
	1954	172	145	84.3	140	143	83.1
	1955	244	217	88.9	212	217	88.9
	1956	189	140	74.1			
	1957	12	5	41.7			
	Total	1,076	926	86.1			
Above medium	1950	23	23	100	22	23	100
	1951	29	29	100	28	29	100
	1952	36	36	100	35	36	100
	1953	29	29	100	28	29	100
	1954	40	40	100	40	40	100
	1955	46	46	100	46	46	100
	1956	29	27	93.1			
	1957	1	1	—			
	Total	233	231	99.1			

TABLE III. BOOSTER INOCULATIONS IN WHITE SOCIO-ECONOMIC CLASSES

Class	Immunized	Boosters given	
		Number	%
Under medium	1,604	16	1.0
Medium	926	29	3.1
Above medium	231	28	12.1

to the fact that the parents of some children stated when the children were immunized but not by whom. In other cases, place of immunization was stated, but as they received one injection only, and this more than 3 months before, they were considered unimmunized. Several of the 75 children mentioned under 'material and methods' fell in this category. It is interesting to note that, at least since

1950, the general practitioners have dealt effectively with the required diphtheria immunization in the A-districts. In the M-districts most of the work (75%) is undertaken by the private doctors, while the municipal clinics are responsible for about 25%, a situation which has remained practically unchanged during the surveyed period. In contrast, the municipal clinics carry the main burden in the poorer districts and their share of the work seems to have been increasing in recent years.

Asiatic Children

A return of 543 questionnaires from the Asiatic, compared to 3,908 from the White group, is proportional to the estimated annual number of live births in the 2 groups.¹⁹ Table V, in which the observations are tabulated,

TABLE IV. PROPHYLACTIC DIPHTHERIA IMMUNIZATION IN WHITE CHILDREN BY GENERAL PRACTITIONERS OR MUNICIPAL CLINICS

Year of birth	Under medium			Medium			Above medium		
	GP	MC	GP%	GP	MC	GP%	GP	MC	GP%
1950	84	81	50.9	54	19	74.0	20	3	87.0
1951	95	93	50.5	55	27	67.1	26	3	89.7
1952	112	115	49.3	104	30	77.6	35	1	97.2
1953	118	121	49.4	97	33	74.6	29	—	100
1954	140	135	50.9	114	31	78.6	38	2	95.0
1955	120	155	43.6	168	49	77.4	42	4	91.3
1956	98	135	42.1	101	41	71.1	26	2	92.9
1957	15	4	—	4	2	—	1	—	—
Total	782	839	48.2	697	232	75.0	217	15	93.5

Figures indicate number of inoculated children. GP = general practitioner, MC = municipal clinic, and GP% = percentage immunization by general practitioner.

TABLE V. PRIMARY COURSE OF DIPHTHERIA IMMUNIZATION IN ASIATIC CHILDREN

Year of birth	Observations	Immunized		Immunized under 2 years of age			Immunized by	
		Number	%	Number	Corrected number	% of observations	GP	MC
1950	39	22	56.4	1	3	7.7	12	9
1951	59	30	50.9	6	10	17.0	14	13
1952	79	26	32.9	7	14	17.7	16	11
1953	94	25	26.6	12	18	19.1	12	12
1954	91	41	45.1	16	36	39.6	23	20
1955	89	29	32.6	19	28	31.5	20	11
1956	85	25	29.4				10	16
1957	7	1	—				—	1
Total	543	199	36.7				107	93

Abbreviations: See Table IV.

shows that just over one-third of the Asiatic children born since 1949 have received a primary course of diphtheria prophylactic. The immunization rates fluctuate somewhat from year to year but by applying a moving average of 3-year periods, it would appear that the immunization rates are falling to about 35% for children born in the later part of the period under consideration. The children immunized before 2 years of age, calculated as in Table III, amount to about one-quarter of the total. Late immunization was the rule among the oldest children in the survey, but the figures indicate a growing tendency towards earlier prophylactic immunization. Not a single Asiatic child received a booster. The last two columns of Table V show that just over half (53.5%) of all immunized children were immunized by a private practitioner and the rest in municipal clinics. This distribution of work has not changed significantly since 1950.

Coloured Children

Compared to the annual number of live births,¹⁰ a slightly higher proportion of questionnaires were completed

TABLE VI. PRIMARY COURSE OF DIPHTHERIA IMMUNIZATION IN COLOURED CHILDREN

Year of birth	Observations	Immunized		Immunized under 2 years of age			Immunized by	
		Number	%	Number	Corrected number	% of observations	GP	MC
1950	46	25	54.4	6	17	37.0	2	24
1951	37	17	45.9	5	11	29.7	1	16
1952	74	44	59.5	12	23	31.1	4	34
1953	69	31	44.9	11	24	34.8	1	34
1954	81	39	48.2	17	35	43.2	2	41
1955	81	37	45.7	17	37	45.7	2	39
1956	100	36	36.0	30			3	36
1957	9	5	—				—	5
Total	497	234	47.1				15	229

Abbreviations: See Table IV.

by Coloured people than by other ethnic groups. The results are presented in Table VI, which shows that just under half the children received a primary course and that the percentage immunized is decreasing slightly among the younger children. About a third of the children were protected before the second birthday with a tendency in recent years towards earlier administration of the primary course. Most of the prophylactic work (93.8%) was done by the municipal clinics and 6.2% by general practitioners, a distribution of labour that has not changed since 1950.



Fig. 1. Organization and average results of prophylactic immunization 1950-55. A, M and U = White socio-economic classes, AS = Asiatic, and C = Coloured.

Comparative Summary

To sum up and compare the above observations, the findings are presented in Fig. 1. The left part of the histogram, giving the total result of prophylactic diphtheria immunization in all age groups, shows that immunization rates fall with reduced socio-economic standard from 99.1% in the A-class to about 40% in the Asiatic and Coloured groups. We do not know if there is a real difference in living standards between the Asiatic and Coloured groups, but it is usually maintained that the Coloured standard is lower. It is interesting to note that along with the decline in immunization rates there is an

even greater decline in the prophylactic work borne by the general practitioners; in other words, the poorer the people the greater the burden which is carried by the municipal clinics. This part of the histogram does not represent the entire work of either of the 2 immunizing bodies, since they also immunize children born before 1950; nor does it reflect the beneficial effect to the community which is related to the amount of prophylactic work carried out in children under 2 years of age.¹⁸ This work, calculated for children born from 1950-55, is presented in the histogram on the right, which shows an even sharper decline in immunization rates with falling standard of living. In conclusion, diphtheria immunization in the poorer White class as well as among non-Whites must be characterized as unsatisfactory both with regard to extent and to time. In fact, it is doubtful whether these low rates influence morbidity and mortality in the respective groups.¹⁸

Immunization Clinics

The proportion of children protected against diphtheria depends upon the attitude of the population towards prophylactic immunization and on the facilities offered for its execution. Prophylactic injections may be obtained against a fee from the general practitioner or free of charge at the municipal clinics. Thus, the municipal clinics are our most important instruments in preventive work. Until 1959, 31 clinics were available in the Johannesburg municipal area; Fig. 2 shows these clinics superimposed on a map of the city's socio-economic districts.¹⁹

The White group was provided with 18 clinics of which 1 was in the A-districts (670 live births *per annum*), 8 in the M-districts (3,140 live births *per annum*), and 9 in the U-districts (5,551 live births *per annum*).¹⁹ Thus, in the White districts 1 clinic was available for every 500-600

children born *per annum*. Five clinics were available for immunization of Asiatic and Coloured children (1,724 live births *per annum*), or 1 clinic per 300-400 children, and 8 for Bantu (13,014 live births *per annum*), or 1 clinic per 1,600-1,700 children.¹⁹ As a rule the clinics were open once a week, some for a few hours, and others for the whole day, but the duration of service was adjusted to satisfy the demand. Excess of work has never forced the clinics to turn people away and no shortage of prophylactic has been encountered. Because of the reduced demand for immunization at the outlying subsidiary clinics, this service for White children was reduced to 3 clinics in 1959, the central immunization clinic in district U5 which is open daily, 1 in district U1 and 1 in U7. Clinics were placed in the latter 2 districts because of the prevalence of diphtheria.²⁰ No alteration has been made in the immunization service for Asiatic, Coloured or Bantu children.

DISCUSSION

In the previous survey on diphtheria immunization of White children in Johannesburg¹⁸ it was found that since 1935 there has been a steady tendency towards increased and earlier administration of the prophylactic. It was calculated from Table II that, of 2,383 White children 1950-54 had been immunized before the age of 2 years, but it was considered doubtful whether the figure was representative.¹⁸ Notwithstanding the slight preponderance of U-class observations in the present material, it may be calculated from Table II, that of 2,383 White children born in that quinquennial, 1,800 (75.5%) had received a primary course of prophylactic and 1,540 (64.5%) received it before 2 years of age, thus showing, as anticipated, that the previous observations for the period were not representative. On the other hand, it also shows that, as compared with the period 1945-49,¹⁸ there has been an improvement in the general immunization rate by at least 7.6% and, in the under-2-year-olds by at least 14.6%. Having registered these favourable signs it must be pointed out that the figures presented demonstrate clearly the inadequacy of prophylactic immunization in the White lower income group both with regard to primary course and booster injections. There are no signs of the boosters becoming more popular since 1955,¹⁸ a regrettable observation because many children, protected for a while by the primary course, may in the absence of silent infections become susceptible to the disease.³ Thus, the omission of booster doses lessens to a large extent the value of the primary course.

The same is true for Asiatic and Coloured children, but in addition the immunization rates are still lower and the boosters still more infrequent. Thus, unless a change takes place we, in Johannesburg, must resign ourselves to the presence of diphtheria and to deaths, which could so easily be avoided. The number of children annually reaching the age of 2 years without immunization is estimated in Table VII. It is based on the annual number of live births¹⁹ corrected for the mortality in the first¹⁹ and second year of life.²² Inadequacy of statistical information renders impossible a similar calculation for the Bantu. The immunization rates are taken from Tables II, V and

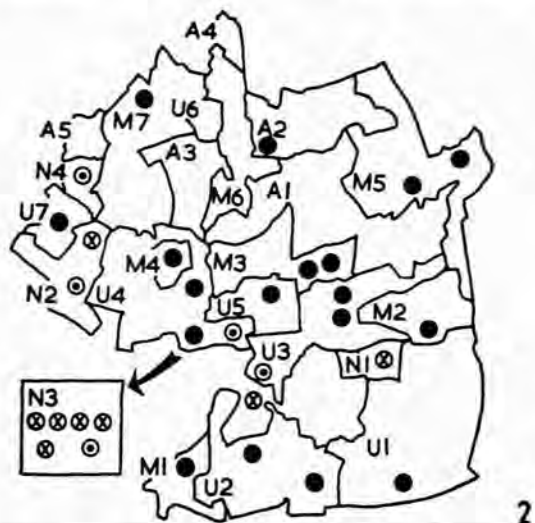


Fig. 2. Geographical distribution of municipal clinics set out on a map of the socio-economic districts of Johannesburg.¹⁹

- Clinics for White children.
- ⊙ Clinics for Asiatic and Coloured children.
- ⊗ Clinics for Bantu children.

TABLE VII. ESTIMATED NUMBER OF CHILDREN ANNUALLY REACHING THE AGE OF 2 YEARS WITH NO IMMUNIZATION

	Annual number of live births	Mortality per 1,000		Survivors at 2nd birthday	Percentage immunized before 2 years of age	Number not immunized at 2 years of age
		1st year of life	2nd year of life			
Above medium	670			644	100	0
Medium	3,140	34.9	4.3	3,017	86.5	407
Under medium	5,551			5,334	53.8	2,464
Asiatic	939	66.3	21.0	858	24.2	650
Coloured	785	133.3	61.0	639	37.9	397
Bantu	13,014	131.1	?	?	?	?

VI. Table VII shows that all children in the A-class have been protected before 2 years of age. In contrast, in the lower White socio-economic classes nearly 3,000 children a year reaching this age are still in need of the primary course of prophylactic. This also applies to about 650 Asiatic, 400 Coloured and an unknown number of Bantu children.

Possible methods of improving this state of affairs may be considered under 3 different headings: (1) parents, (2) general practitioners, and (3) health authorities and the municipal clinics.

1. Parents

When responsible parents know that diphtheria is a dangerous but preventable disease they will have their children immunized; but if they do not hear of diphtheria among children they know, it is understandable that the urge for its prevention may lessen. Therefore, as pointed out by Woodrow²⁴ and the Ministry of Health,²⁵ continuous publicity is essential to bring home to parents and guardians of young children not merely their responsibilities but also how, when and where they can take advantage of the health services provided.

The Ministry of Health²⁵ stresses the importance of team work 'in which family doctors, health visitors, district nurses, staffs of welfare centres and voluntary workers play their part. Personal persuasion is still the most powerful element in any local campaign and will benefit from the "background" publicity afforded by the local press, advertisements, posters, cinema-slides and one-minute films, etc.'. We fully endorse this and may add that use could also be made of postage stamps, radio propaganda and reminders enclosed in packets of baby food, etc.²⁴ It is our view that in Johannesburg, although most of the above steps are taken, far more could be done in the publicity and propaganda field.

2. General Practitioners

It is maintained that parents and guardians on the whole prefer to have their children immunized by their private doctor rather than by the municipal clinic. This is also confirmed in the present survey, where the socio-economic standard is closely related to the general practitioner's contribution to prophylactic immunization. It is possible, therefore, that some parents with an indifferent attitude to immunization may abstain from having it done on the grounds that they are opposed to the municipal clinics and cannot afford medical fees. This might be overcome either by popularizing the municipal clinics through apt advertisements or by introducing a system whereby the general practitioner can perform the inoculation against a fee chargeable to the municipal authorities.

Such a system has been in successful operation in Den-

mark for many years. Shortly after confinement—for instance on the health visitors' call to the home of a newborn child—the mother is issued with a card bearing the baby's name and birthday. The card has 3 squares, each with a note on the appropriate time for the first, second and third inoculation, which serve as very valuable reminders to the mother. On her immunization visits to the private doctor, she detaches a square, signs it and hands it over. The doctor recovers his fees by submitting the signed squares to the municipal authorities. This system benefits the child, the general practitioner, the state and the exchequer; it is much cheaper to prevent than to treat diphtheria.

From this study it is clear that general practitioners, given the facilities, are able to cope adequately with required immunization. However, their attention must be drawn to the importance of giving a booster a year after the primary course, which has been neglected in the past. They could probably assist further by encouraging and persuading poorer parents to have their children immunized. The rôle of the general practitioner would be considerably increased by the introduction of a card system as described above.

3. Health Authorities and the Municipal Clinics

The organization of prophylactic immunization rests mainly on the health authorities. It is their responsibility to advise on practical methods of immunizing the population and as far as possible to create the necessary facilities. The results may be checked through studies of morbidity and mortality rates and, if found unsatisfactory, surveys should be conducted to detect possible errors or methods of improvement. This may involve, as already suggested, publicity campaigns, introduction of a card system and instruction to all immunizing bodies on the importance of boosters.

A further duty of the local health authorities is the administration of the municipal immunization clinics. In view of the urgent need for immunization, the recent decision to stop immunization at the subsidiary clinics and concentrate the effort at the central clinic every day would appear to be a retrograde step, since they may have been able to fill a need and serve a useful purpose, particularly if the public's indifference could be counteracted by more publicity campaigns.

From time to time authors have suggested compulsory immunization,^{16,26} which undoubtedly is effective and has been introduced in some countries.²⁶⁻²⁸ Other countries have managed the problem on a voluntary basis, a system we feel should continue until it has been conclusively established that it will not result in the elimination of diphtheria.

SUMMARY

1. On the basis of questionnaires the extent of prophylactic diphtheria immunization has been examined among White, Asiatic and Coloured children in Johannesburg, born between 1950 and 1957. It was not possible to include Bantu children in this survey.

2. The immunization rates (primary course) for children 1-7 years of age drop from 99.1% in the highest socio-economic class to about 40% in the poorer classes. These rates have remained almost static since 1950.

3. The immunization rates in children under 2 years of age are directly related to socio-economic standard. Since 1950 there has been a slight tendency towards earlier immunization in the Asiatic and Coloured groups, while no significant trend can be shown in the White population.

4. In all the races surveyed, the proportion protected is still grossly inadequate for the elimination of the disease. It is estimated that about 3,000 White children and 1,000 Asiatic and Coloured children annually reach the age of 2 years without immunization.

5. Booster injections are almost entirely ignored.

6. The proportion of prophylactic injections given by general practitioners falls with declining socio-economic status of the population and the reverse holds for municipal clinics.

7. The findings are discussed and alterations suggested which might lead to more children being immunized against diphtheria.

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