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Paralytic Poliomyelitis Incidence as a Guide to Vaccination

E. H. LOSSING, M.D., M.P.H.¹

AT the beginning of the Canadian poliomyelitis immunization program in April 1955, the early primary school-age group was selected for vaccination by the majority of provinces. As the programs developed, vaccinations were progressively extended to include pre-school and older school-age children. By the beginning of the poliomyelitis "season" of 1958 it is estimated that in excess of 4,000,000 children will have been vaccinated. With the exception of pregnant women and certain occupational groups considered to be at special risk, few vaccinations will have been given to persons over 20 years of age.

This pattern evolved because with limited supplies of vaccine in the early stages of the program it seemed only logical that priority be given to the most vulnerable ages. The soundness of the decision to vaccinate first the early school ages and to extend vaccinations progressively to pre-school and older school ages will be seen from Tables 1 and 2. It will be noted that the largest proportion of all paralytic cases in each of the pre-vaccination years except 1953, and the highest paralytic attack rates in each year from 1952 to 1954,

TABLE I—PARALYTIC POLIOMYELITIS
Percentage Distribution by Selected Age Groups, 1952–1956, Canada*

Age Groups	1952		1953		1954		1955		1956	
	Cases	% Dist.	Cases	% Dist.	Cases	% Dist.	Cases	% Dist.	Cases	% Dist.
Under 1	67	4.4	116	3.3	12	4.6	4	1.2	3	1.5
1	33	2.1	159	4.5	19	7.7	15	4.7	21	10.3
2	58	3.8	212	6.0	30	12.9	24	7.5	20	9.8
3	74	4.8	236	6.7	28	12.4	23	7.2	25	12.3
4	62	4.0	216	6.1	18	8.2	17	5.3	14	6.9
0-4	294	19.2	939	26.1	107	22.7	83	25.8	83	40.9
5-9	372	24.3	831	23.7	122	25.8	54	16.8	33	16.2
10-14	232	15.1	399	11.4	52	11.0	41	12.8	21	10.3
15-19	169	11.0	249	7.1	46	9.7	29	9.0	10	4.9
20-24	140	9.1	293	8.3	37	7.8	33	10.3	18	8.9
25-29	130	8.5	324	9.2	39	8.3	30	9.3	16	7.9
30-34	118	7.7	243	6.9	21	4.4	28	8.7	10	4.9
35-39	41	2.7	121	3.4	24	5.1	16	5.0	11	5.4
40 & Over	37	2.4	111	3.2	24	5.1	7	2.2	1	0.5
All Ages	1,533	100.0	3,510	100.0	472	100.0	321	100.0	203	100.0

*8 Provinces Only.

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TABLE 2—PARALYTIC POLIOMYELITIS
Rates per 100,000 Population by Selected Age Groups, 1952–1956, Canada*

Age Groups	1952	1953	1954	1955	1956
Under 1	28.7	46.2	4.6	1.5	1.1
	15.1	67.9	7.7	5.7	8.0
	26.8	95.9	12.9	9.5	7.9
	34.7	108.1	12.4	9.9	10.7
	28.3	100.2	8.2	7.5	6.2
0–4	26.7	82.3	9.0	6.7	6.4
5–9	41.8	88.7	12.4	5.3	3.0
10–14	32.3	53.2	6.6	5.0	2.4
15–19	25.8	37.6	6.8	4.2	1.4
20–24	20.7	43.2	5.4	4.8	2.6
25–29	17.7	43.9	5.2	4.0	2.1
30–34	17.0	34.5	2.9	3.8	1.3
35–39	6.1	17.7	3.4	2.3	1.5
40 & Over	1.2	3.5	0.7	0.2	0.0
All Ages	16.5	37.0	4.8	3.2	1.9

*8 Provinces Only.

were to be found in the 5–9 age group, followed by the pre-school ages and older school-age children.

With increasing availability of vaccine it is important to consider the future course of vaccination programs. It is of interest to look to our Canadian experience over the past few years for any guidance that incidence patterns may offer. With the co-operation and assistance of Provincial Communicable Disease Control Directors and Epidemiologists, incidence figures of paralytic poliomyelitis by age for 1952 and subsequent years have been assembled for this purpose.

Age Distribution of Cases:

An examination of the percentage distribution of paralytic poliomyelitis by 5-year age groups is helpful (Table 1). It will be seen that the age distribution pattern in the pre-vaccination years 1952–54 and post-vaccination years 1955–56 is generally similar except that the peak of maximum distribution previously noted in the age group 5–9 has been displaced. In both 1955 and 1956, the maximum distribution of paralytic cases occurred in the 0–4 age group, and declined progressively through successive age groups except for ages 15–19 where in both years the distribution was low. It will be noted that in the years 1955 and 1956, 36 and 28% respectively, of all paralytic cases occurred at the age of 20 and over, and 16 and 11% occurred in those of 30 years of age and over. In the same years 7 and 6% of all paralytic cases occurred at 35 years and over.

Paralytic Attack Rates:

A consideration of age specific paralytic attack rates (Table 2) shows that the risk of paralytic poliomyelitis was greatest in the 5–9 age group in pre-vaccination years, but since 1955 the highest rates are to be found in ages 0–4. From this peak in the pre-school years there is a progressive decline with age, although the rate of decline is not large. In each post-vaccination year the attack rate at ages 35–39 was approximately half that at ages 5–9 years.

Paralytic Poliomyelitis in Pre-School Ages:

Since incidence rates and the proportion of paralytic cases occurring in the 0-4 age group are particularly high, it is of interest to examine each year of the pre-school ages separately. It is seen that the picture is much different in infants under one year of age than in any other early year of age. (Tables 1 and 2). Paralytic cases under one year of age contributed only 1.5% of all paralytic cases in 1956 and the risk of paralytic poliomyelitis in infancy as measured by case rates is relatively small, although it will be shown that case fatality rates in infancy are high. It should be noted, however, that with the exception of infants under one year of age, paralytic attack rates in 1955 and 1956 have been higher in each individual year under 5 years of age than in any of the older age groups.

Although poliomyelitis in infants is reported as "under one year of age" and not by the exact month of age, figures that are available, although incomplete, indicate that paralytic poliomyelitis occurring under six months of age is comparatively infrequent. This can probably be attributed to protection given by passively transmitted maternal antibodies since Brown and Smith (1) have shown that when high titres of antibody were present in the maternal blood, passively transmitted antibodies were demonstrated in the infant for 2 to 3 months. These authors have also indicated that vaccination commenced in young infants gives as satisfactory an antigenic response as vaccination in pre-school and school-age children.

Case Fatality Rates:

Although the incidence of paralytic poliomyelitis has been shown to decline with age, the risk of death in those developing paralytic poliomyelitis after infancy, increases with age as is demonstrated in Table 3. In 1952 and 1953 a similarity in case fatality patterns will be noted. The risk of dying from a paralytic attack was high in the very young, lower in the pre-school ages and increased rapidly through the school and adult ages. In the year 1954 the rise in fatality with age is not evident until the early adult ages, but from the age of 25 it increases with age as in 1952 and 1953. The case fatality pattern

TABLE 3—PARALYTIC POLIOMYELITIS
Case Fatality Rates (Deaths per 1,000 Cases) by Selected Age Groups, 1952-1955, Canada*

Age Groups	1952	1953	1954	1955	Average 1952-55
Under 1	149.2	94.8	83.3	—	110.5
1-4	101.3	34.0	94.7	38.0	51.4
5-9	112.9	43.3	82.0	55.5	66.0
10-14	129.3	77.7	76.9	48.8	92.5
15-19	106.5	104.4	21.7	34.5	93.3
20-24	192.8	197.9	54.0	121.2	180.9
25-29	192.3	160.5	128.2	33.3	158.7
30-34	194.9	164.6	142.8	71.4	165.8
35-39	268.3	289.2	250.0	61.9	262.4
40 & Over	297.3	207.2	333.3	285.7	245.8
All Ages	143.5	96.9	103.8	59.2	111.4

— Deaths nil.

*8 Provinces Only.

in 1955 is unstable due to the small number of cases and deaths experienced in that year. At the time of writing (April 1957) deaths by age are not available for the year 1956. It will be seen, however, from the case fatality averages for the years 1952-55, that the risk of death in those developing paralytic poliomyelitis at ages 35-39 is about 2½ times the risk under one year of age and about 5 times the risk in the pre-school ages.

Deaths from Poliomyelitis:

The pattern of death rates per 100,000 population for individual years 1952 to 1955 and the averages for these four years are illustrated in Table 4. In the 4-year averages the rise in death rates seen in the school ages is followed by a

TABLE 4—POLIOMYELITIS DEATHS
Rates per 100,000 Population by Specified Age Groups, 1952-1955, Canada*

Age Groups	1952	1953	1954	1955	Average 1952-55
0-4	3.0	3.4	0.8	0.2	1.8
5-9	4.7	3.8	1.0	0.3	2.4
10-14	4.2	4.1	0.5	0.2	2.2
15-19	2.7	3.9	0.1	0.1	1.7
20-24	4.0	8.5	0.3	0.6	3.3
25-29	3.4	7.0	0.7	0.1	2.8
30-34	3.3	5.7	0.4	0.3	2.4
35-39	1.6	5.1	0.8	0.1	1.9
40-44	0.8	2.3	0.5	0.3	1.0
All Ages	2.4	3.6	0.5	0.2	1.6

*8 Provinces Only.

decline at ages 15-19. A rise to a maximum rate at ages 20-24 then occurs with death rates thereafter tending to decline gradually with age. It should be noted, however, that the death rate at ages 30-34 years is as high as it is in the early school years, while even at ages 35-39 the death rate in some years was higher than in ages 15-19.

The percentage distribution of deaths by 5-year age groups (Table 5) shows that the distribution in each 5-year age group up to 34 years of age,

TABLE 5—POLIOMYELITIS DEATHS
Percentage Distribution by Specified Age Groups, 1952-1955, Canada*

Age Groups	1952	1953	1954	1955	Average 1952-55
0-4	15.0	11.5	20.4	15.8	13.5
5-9	19.1	10.6	20.4	15.8	14.5
10-14	13.6	9.1	8.2	10.5	10.7
15-19	8.2	7.6	2.0	5.3	7.3
20-24	12.3	17.0	4.1	21.0	14.5
25-29	11.4	15.3	10.2	5.3	13.2
30-34	10.4	11.8	6.1	10.5	10.8
35-39	5.0	10.3	12.2	5.3	8.4
40-44	2.3	4.1	6.1	10.5	3.8
45 & Over	2.7	2.7	10.2	—	3.3
All Ages	100.0	100.0	100.0	100.0	100.0

— Deaths nil.

*8 Provinces Only.

and even to age 39 in some years, is essentially the same except for the age group 15-19 years in which the proportion of deaths is low. In the 5-year averages slightly over 25% of all deaths occurred in ages 30 and over, and 15% in ages 35 and over. Only 7% of deaths occur in the 40 and over group.

SUMMARY

Age distribution patterns of paralytic cases and poliomyelitis deaths in the past few years have been examined to determine the guidance that our experience with poliomyelitis may offer to continuing vaccination programs in Canada. It is shown that in the post-vaccination years 1955 and 1956 the largest proportion of all paralytic cases had shifted to the pre-school ages. Between 28 and 36% of all cases occurred in ages 20 and over, and 11 to 16% at ages 30 and over. It is to be noted that approximately the same proportion of all cases occurred at ages 30-34 as in ages 15-19 in these two years. Since vaccinations commenced, the risk of developing paralytic poliomyelitis as measured by attack rates per 100,000 population is shown to be greatest in the pre-school years, and in general to decline gradually with age. It is of interest, however, to note that in the year 1956 the risk of paralytic poliomyelitis at ages 30 to 39 years was as high as in the high school ages (15-19 years). High attack rates at each individual year of age under 5, with the exception of infants under one year, are shown. An examination of case fatality rates indicates that paralytic poliomyelitis is particularly lethal in the very young and after a regression in childhood becomes increasingly deadly during the adult years. Under the age of one year, an average of 11% of paralytic poliomyelitis cases died. Mortality was 5% in the pre-school child, 6 to 9% in the school ages, approximately doubled during young adult years, and reached a peak of 25% in persons 35 and over. It is shown that death rates and the distribution of deaths remained reasonably constant through all ages up to 34, except for a deficiency at ages 15-19 years. Over half of all deaths occur in persons 20 years and over, some 25% over the age of 30, but only 7% in the 40 and over group.

CONCLUSIONS

Several factors indicate clearly the need for commencing vaccinations at an early age. Among these are the high case fatality rates in the very young, the large proportion of all paralytic cases occurring in the pre-school ages as a group, and the high attack rates seen in each individual year of age from one to four. Since it appears that antigenic response is satisfactory in the young infant, vaccination commencing as early as three months of age is desirable.

The observation that one-third of all paralytic cases and over one-half of all poliomyelitis deaths occur in persons over 20 years of age, combined with the persistence of comparatively high case and death rates and the increasing case fatality rates in the older adult ages suggest the need for adult vaccination. It would appear that vaccination of adults, particularly the parents of pre-school and school-age children, would be desirable up to 40 years of age.

1. Brown, G. C. and Smith, D. C.: *J. Am. Med. Assoc.*, 1956, *161*: 399.