POLIOMYELITIS AND THE SOCIAL ENVIRONMENT

BY

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One of the most striking but unexplained characteristics of poliomyelitis, to which many workers have drawn attention, is its relatively greater incidence and epidemicity in countries with high standards of living and good sanitation. In contrast it has "remained endemic and sporadic in countries where living conditions are poor, sanitary facilities minimal or non-existent, and infant mortality high" (Horstmann, 1948). Correspondingly, while water supplies and means of excreta disposal have been improved, while social conditions and nutrition have been steadily advancing, the disease has risen in many countries from sporadic or only small-scale appearances to epidemics on a wide scale. There seems no doubt whatever that this change is predominantly real, though its actual magnitude may well be exaggerated by the increasing attention paid during the last 50 years to the abortive and non-paralytic cases.

Somewhat similarly, the early literature on poliomyelitis contains constant references to the victims of the disease as healthy and strong children—indeed, Heine himself made such comment over a hundred years ago. This observation—if in fact the disease does fall with significantly greater frequency upon such children—might be explicable on the grounds that the strong and healthy by taking more muscular activity run a greater risk of bringing themselves into the paralytic class and thereby of being more often observed (Russell, 1947).

It has also been stated, and not infrequently, that the cases in a localized outbreak have been unduly concentrated in the better and more sanitary parts of the area. Thus, for example, Gilloran (1949) quotes the report of the medical officer of health for Beaminster rural district (Dorset) on a small outbreak in 1914: "The cases nearly all occurred . . . in the least-crowded and most sanitary part of the town on the main street." Going further afield, an inverse relationship between population density and attack rate was reported in the Mauritius outbreak of 1945 (McFarlan *et al.*). There is no dearth of such comments in the literature.

More recently, and arising out of the unprecedented epidemic that took place in Great Britain in 1947, it has been suggested that within a country exposed to a widely spread outbreak the incidence is likely to fall more heavily upon the communities that enjoy the most favourable environment and the best social conditions. Thus in a discussion of the poliomyelitis experience of the borough of Luton in 1947 it was said that "the birth rate was 21.3, death rate 9.4, infantile mortality rate 36, stillbirth rate 21.3, and maternal mortality rate 0.8. The outbreak was therefore set in circumstances of good health and low infection—a characteristic of poliomyelitis which seems to favour populations in favourable conditions where public health services are above the average" (*Med. Off.*, 1948).

Such striking events, however, may easily meet the eye and lead to comment while more normal or more expected

happenings naturally tend to go unobserved and unrecorded. A full statistical account of the distribution of cases in relation to social environment is needed, and this we have attempted for the epidemic of 1947.

The Statistical Data

Through the kindness of the Registrar-General we were provided with the number of corrected notifications of poliomyelitis (including polio-encephalitis) in each of the 125 great towns and the 148 smaller towns of England and Wales in the year 1947. From these we computed the poliomyelitis attack rate during the year in each town (necessarily the crude rate at all ages, since attacks by ages are not available).

In the absence of a census since 1931 we have no up-to-date measure, in these towns, of overcrowding or of social-class attributes to use as our index of environment. Such characteristics are, however, invariably correlated closely with the infant mortality rate and to some extent, but less closely, with the general death rate. These, it will be recalled, were used as evidence of the social setting of the epidemic in Luton. As an indirect index of the environment we have therefore used these rates as computed for each town in the two years previous to the epidemic, 1945 and 1946 (the mean rate for these years).

Results

Correlation of the recorded attack rate from poliomyelitis with the specified mortality rates gave the following results (coefficients of correlation):

	125 Great Towns	148 Smaller Towns
Attack rate of poliomyelitis and crude death rate	-0.10	.. +0.04
Attack rate of poliomyelitis and infant mortality rate	-0.04	.. -0.13

These coefficients are all technically insignificant and therefore reveal no association between the incidence of poliomyelitis and the total and infant death rates of the towns.

The infant mortality index covers, by definition, the whole of the first year of life. It is, however, well known that the social and economic environment is mainly correlated with the mortality of the latter parts of the first year of life and less closely associated with deaths in the neonatal period. We therefore computed the degree of association between the attack rates of poliomyelitis and the infant mortality experiences of the great towns in 1945, limited to the ages 1-12 months and 6-12 months. The coefficients of correlation were as follows:

	125 Great Towns
Attack rate of poliomyelitis and infant mortality at 1-12 months of age	.. +0.08
Attack rate of poliomyelitis and infant mortality at 6-12 months of age	.. -0.07

Once more the coefficients are very small and again they are technically insignificant.

Reverting, therefore, to the total infant mortality rate—i.e., over the whole of the first year of life—the distribution of the poliomyelitis incidence in the total 273 towns in relation to this social index may be shown as in the table on the next page.

As follows inevitably from the insignificant correlations shown above, there is at every level of infant mortality a very wide scatter in the level of epidemicity of poliomyelitis. Over infant mortality rates ranging from 30 to 60 per 1,000 there is clearly no material difference between the percentage distributions showing the frequency with which different attack rates of poliomyelitis were recorded. At the two extremes of infant mortality, under 30 and

Number of Towns Showing Given Infant Mortality Rate in 1945-6 and Given Poliomyelitis Incidence in 1947

Poliomyelitis Attack Rate per 100,000 Inhabitants	Infant Mortality Rate per 1,000 Live Births					
	Under 30	30-39	40-49	50-59	60+	Total
Under 5	—	18	12	10	4	44
5-9	1	23	19	12	8	63
10-14	2	18	23	11	6	60
15-19	7	18	8	11	2	46
20-24	2	7	6	4	—	19
25-29	1	2	2	7	1	13
30+	3	11	5	6	3	28
Total	16	97	75	61	24	273

Percentage Distribution					
Under 10	6.3	42.2	41.3	36.1	50.0
10-19	56.3	37.1	41.3	36.1	33.3
20-29	18.8	9.3	10.7	18.0	4.2
30+	18.8	11.3	6.7	9.8	12.5
Total	100.2	99.9	100.0	100.0	100.0

over 60, it might be thought that there was at the lower end a slight excess of towns with a high poliomyelitis incidence and at the upper an excess with a low attack rate. But the numbers of towns in these extreme categories are small and the scatter of poliomyelitis rates obviously very wide. Clearly, therefore, a very favourable rate of infant mortality, and thereby, as a rule, favourable social conditions, need lead to no alarm that an unduly high incidence of poliomyelitis will inevitably, or even probably, be experienced in an epidemic year.

Experience of London

The incidence of poliomyelitis in London in the 1947 epidemic has been studied in detail by Daley and Benjamin (1948). To test the relationship between incidence and social conditions they correlated the attack rate in the 28 boroughs with the proportion of males aged 14+ who were in social groups IV and V at the 1931 census (the least skilled occupationally). The coefficient of correlation resulting was +0.13, an insignificant value. On the other hand, between incidence in the 28 boroughs and number of persons per dwelling they did find an appreciable degree of correlation—namely, -0.48—indicating that the more persons per dwelling there were the lower was the attack rate. In explanation the authors suggest that when the virus enters a household it may usually infect all persons but will in most instances produce an overt attack in only one member. It would then follow that the larger the household the smaller on the average would be the proportion of overt attacks.

As an index of social conditions the proportion of persons living more than two to a room would clearly be preferable to the absolute number of persons per dwelling. We have therefore correlated the former with the incidence of poliomyelitis in the London boroughs in 1947, and reach a coefficient of +0.29. This insignificant (and positive) value is in accordance with that found by Daley and Benjamin between the attack rate and proportion of males in the lowest social classes. These correlations for London suffer, it may be noted, from the defect that the indices of conditions are based upon the 1931 census. The relative gradings of the London boroughs may not have undergone serious changes since then, but that is an assumption that must be made.

Summary

It has been suggested that towns with favourable health conditions as revealed by low infant and general mortality rates are peculiarly liable to a heavy incidence of poliomyelitis when that disease becomes epidemic. The recorded notifications of poliomyelitis in the 273 large and small towns of England and Wales show no such association between the attack rates

they suffered in the 1947 epidemic and the infant and general death rate they experienced in the two preceding years, 1945-6. In other words, according to this experience, favourable mortality rates, indicating favourable social conditions in a locality, need not raise fears of an unduly heavy risk when poliomyelitis becomes widespread.

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PRODUCTION OF DENTAL CARIES

A NEW HYPOTHESIS

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Structure of Teeth, with Reference to Occlusal Grooves and Development

Human molar teeth show cusps on the biting surfaces; between the cusps lie grooves. The biting surfaces are known as occlusal surfaces, and the grooves as occlusal grooves. It is of some importance to note that these grooves are commonly the site of caries, especially in the case of the lower first molars. In considering the mode of production of caries the contents of the occlusal grooves must be taken into account, since the grooves themselves are often so narrow that the contents are unlikely to be removed by the chewing of food or the use of a toothbrush. Soon after eruption the contents of shallow occlusal grooves are lost. However, in the present work it is not towards these but towards the narrow inaccessible grooves that attention is directed.

Enamel is laid down by cells (ameloblasts) which move from within outwards, depositing soft enamel matrix, which later hardens to become mature enamel. The passage of the ameloblasts is marked by the traces of organic material which remain between the prisms. The highest concentrations of organic material in enamel are found between the prisms, while the prisms themselves are permeated by organic material.

The enamel can be distinctly seen radiographically only when calcification occurs; this takes place first at the cusp tips and later gradually spreads over the rest of the tooth crown (Applebaum, 1943). Calcification is a late stage in the development of the enamel; finally, the enamel undergoes a process of maturation. Teeth

FIG. 1.—Diagrammatic representation of the order in which calcification occurs in a molar tooth. The formation of an occlusal groove is seen. Drawings based on x-ray appearances. E=Enamel, D=Dentine.