POLIOMYELITIS IN ENGLAND AND WALES, 1947-1950

BY

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Poliomyelitis has been endemic in England and Wales since its notification was made compulsory in 1912, but prior to 1947 its incidence was, with the exception of three years, of the nature of a sporadic disease with a seasonal rise rather than that of an epidemic disease. This was in contrast to the experience of the United States and some continental countries, where large epidemics had occurred periodically. On the other hand, the vagaries of the disease in England and Wales between the two wars presented some interesting and puzzling features. The fatality rate, i.e. the proportion of deaths to notified cases, varied greatly from year to year; for example, the notifications in 1926 were three times the 1925 level but the fatality rate only half. On the whole, the yearly deaths from poliomyelitis varied only slightly in number, and the concomitant large variations in the notifications would (if they can be accepted as accurate) suggest that the severity of the disease was changing from year to year. Similarly, the incidence of notifications increased more than the mortality during the seasonal period of greater prevalence. This was possibly due to an increased recognition of milder cases at the times when the disease was known to be most likely to occur. The Registrar-General, discussing this possibility, wrote:

There is evidence that milder cases of the disease are often overlooked, its characteristic after-effects being met with in persons in whom the early stages of the disease have never been recognized.

The only large outbreaks of the disease in England and Wales before the epidemics of 1947-50 occurred in 1926, 1938, and 1940, when 1,159, 1,489, and 1,079 cases were notified. From these occurrences the outbreak of 1947 differed not only in magnitude—708 cases were notified in the week of maximum prevalence—but also in the geographical and age distribution of the patients. This outbreak, in fact, appears to mark a distinct change in the incidence of poliomyelitis in England and Wales, for though a steep decline was recorded in 1948, the incidence remained considerably above the previous endemic level and the year's notifications were larger than those of any year prior to 1947. Any hopes that poliomyelitis would follow a similar trend to that exhibited by cerebrospinal fever after the epidemic of 1941 (when the succeeding outbreaks gradually diminished in size until an endemic level slightly above the original endemic level was reached) were disappointed when large outbreaks of poliomyelitis appeared in 1949 and 1950.

Characteristics of the recent outbreaks have been an apparent change in infectivity and concentration of the disease. It has always been believed that the occurrence of multiple cases of poliomyelitis in a family or even in a household was a very rare event. During the last epidemics two cases in a household were not infrequently reported, and in 1949 three cases of the disease occurred in each of three households in the Isle of Wight (Bradley, 1950). In earlier outbreaks, centres of high incidence generally occurred and there was not much evidence of a spread of infection. Thus in 1926 the neighbouring counties of Leicester, Nottingham, and Warwick contributed 21 per cent. of the total notifications of the country, the population of this area being only 6·7 per cent. of that of the whole country. In 1938, the notifications in London and Essex were 21 per cent. of the total, the population being 14·5 per cent. of the total; in 1940, 34 per cent. of the total cases were notified in Lancashire and Yorkshire West Riding where the population was 13·2 per cent. of that of the whole country. On the other hand, the concentration of the bulk of the cases in a limited area practically disappeared in the recent epidemics, although in 1950 the counties of Warwick, Gloucester, and Stafford had 19 per cent. of the total notifications of the country. The regional distribution for the last 4 years is shown in Table I. The chief features of Table I are the light incidence in 1949 in Wales (particularly North Wales) and in the northern counties, and the high attack rate in 1950 in the west midland counties.

TABLE I
REGIONAL DISTRIBUTIONS

Region	Notifications per Million				Rate as Percentage of Total			
	1947	1948	1949	1950	1947	1948	1949	1950
London	326	61	264	172	148	120	168	82
South Eastern ..	249	51	173	223	113	100	110	106
South Midlands ..	218	73	172	152	99	143	110	72
Eastern	163	49	191	165	74	96	122	79
South Western ..	162	73	211	295	73	143	134	140
West Midlands ..	208	52	111	386	94	102	71	184
North Midlands ..	205	49	163	206	93	96	104	98
North Western ..	209	38	110	129	95	75	70	61
Yorkshire	230	40	188	168	104	78	120	80
Northern	272	29	85	196	123	57	54	93
Wales 1	153	57	96	141	69	112	61	67
Wales 2	173	35	35	238	78	69	22	113
Total England and Wales ..	221	51	157	210	100	100	100	100

MORTALITY

The age distribution of the deaths from poliomyelitis in 1947 showed a distinct shift compared with earlier outbreaks. The youngest ages formerly supplied the bulk of the deaths, but in 1947 the disease took a much increased toll of the early middle ages. The percentage of deaths under the age of 20 and between the ages of 20 and 45 were 80 and 17 in 1926, 74 and 22 in 1938, and 55 and 41 in 1947.

This change in the age distribution of the deaths was accompanied by an increase in the ratio of male to female deaths. Male deaths expressed as a percentage of female deaths were 118 in 1926, 112 in 1938, and 145 in 1947. The fatality rate fell in the 1947 epidemic, for the notifications in this year were 6.6 and 5.2 times the totals of 1926 and 1938, but the deaths were only 2.9 and 2.7 times as many. The fatality rate rose with age during the more recent outbreaks, the increase being larger for males than for females. The rates are shown in Table II.

TABLE II
DEATHS AS PERCENTAGE OF CORRECTED NOTIFICATIONS, ENGLAND AND WALES

Ages	1947		1948		1949	
	Males	Females	Males	Females	Males	Females
0-	5.8	5.0	2.7	5.5	5.8	6.2
5-	5.2	5.2	10.4	6.2	7.9	6.2
10-	8.0	6.5	8.6	6.7	7.7	7.9
15-	13.7	10.1	25.9	20.1	14.1	18.2
25+	21.8	16.1	32.3	23.6	30.4	23.7

NOTIFICATIONS

The epidemic curves for 1947, 1949, and 1950 varied in shape. In 1947 the notifications rose rapidly from the 23rd week to a maximum of 691 in the 33rd week, declined for two weeks and then, after a further increase to 708, steadily declined to the end of the year. In 1949 the rise to a peak was much slower and more irregular and the maximum incidence of 563 was not reached until the 41st week, from which time there was a continuous decline. In 1950 the outbreak began earlier, but the peak incidence occurred in much the same period as in 1947, the maximum being attained in the 34th week with 589 cases; the subsequent decline was interrupted by occasional small rises. The three epidemics show asymmetrical distributions. Their course is shown in the Figure.

REGIONAL DISTRIBUTION

The notification rates per million for 1947-50 are shown for each county, and for county boroughs, urban districts, and rural districts of each county, in Table III. For England and Wales as a whole there is, it will be seen, very little difference in incidence between the three density areas. Within the counties there are occasional large differences between the types of area, due to intensive outbreaks in particular areas. Thus, in 1947, the rural districts of Surrey had an incidence rate slightly over twice that of the county as a whole, a feature due mainly to an outbreak in Hambledon R.D. with a rate of 1,148 per million. Similarly, the high rate in the urban districts of Bedfordshire in 1947 was mainly due to the unfavourable experience of the town of Luton. Other small areas with a high attack rate in that year included the rural districts of Aysgarth and Bedale in the North Riding of Yorkshire, and Shildon U.D. in the county of Durham. The chief feature of the distribution of the notifications in 1949 was the low incidence in the northern

FIGURE.—Notifications of Poliomyelitis, England and Wales, 1947-50.

counties and in Wales, particularly North Wales. The large attack rate in Cornwall was due to an outbreak extending over the districts of Camborne-Redruth U.D., Truro M.B., and Truro R.D., with a combined rate of 780 per million. Bristol had the largest epidemic among the county boroughs, and the experience

TABLE
ACUTE POLIOMYELITIS IN
Notifications

COUNTIES								1947			
								County	C.B.s	U.D.s	R.D.s
LONDON	..	..	..	..	..	..	..	326			
	Surrey	..	..	..	..	..	..	292	318	248	617
	Kent	..	..	..	..	..	..	241	123	243	242
	Sussex	..	..	..	..	..	..	248	252	214	285
	Hants	..	..	..	..	..	..	226	184	238	293
	Berks.	..	..	..	..	..	..	174	88	208	212
SOUTH EASTERN	..	..	..	..	..	..	..	249	217	240	304
	Middlesex	..	..	..	..	..	..	237		237	
	Hertford	..	..	..	..	..	..	236		233	245
	Bucks.	..	..	..	..	..	..	130		136	125
	Oxford	..	..	..	..	..	..	212	212	242	200
	Northants	..	..	..	..	..	..	133	224	56	171
	Hunts.	..	..	..	..	..	..	149		214	92
	Bedford	..	..	..	..	..	..	386		458	217
	Cambridge	..	..	..	..	..	..	93		103	81
SOUTH MIDLANDS	..	..	..	..	..	..	..	218	218	230	168
	Essex	..	..	..	..	..	..	156	102	166	207
	Suffolk	..	..	..	..	..	..	170	60	218	195
	Norfolk	..	..	..	..	..	..	182	263	203	128
EASTERN	..	..	..	..	..	..	..	163	134	172	171
	Wilts.	..	..	..	..	..	..	198		129	267
	Dorset	..	..	..	..	..	..	289		256	347
	Devon	..	..	..	..	..	..	112	86	124	128
	Cornwall	..	..	..	..	..	..	138		168	102
	Somerset	..	..	..	..	..	..	161	235	110	186
SOUTH WESTERN	..	..	..	..	..	..	..	162	120	152	190
	Gloucester	..	..	..	..	..	..	216	221	164	235
	Hereford	..	..	..	..	..	..	398		302	465
	Salop	..	..	..	..	..	..	140		142	139
	Staffs.	..	..	..	..	..	..	151	156	136	177
	Worcester	..	..	..	..	..	..	160	90	140	284
	Warwick	..	..	..	..	..	..	265	257	311	244
WEST MIDLANDS	..	..	..	..	..	..	..	208	215	180	234
	Leicester	..	..	..	..	..	..	232	386	103	103
	Rutland	..	..	..	..	..	..	158		279	130
	Lincs.	..	..	..	..	..	..	336	348	247	402
	Notts.	..	..	..	..	..	..	120	65	140	182
	Derby	..	..	..	..	..	..	162	158	177	146
NORTH MIDLANDS	..	..	..	..	..	..	..	205	234	169	219

of this city adversely affected the rate for Gloucestershire. In 1950 there was a definite peak of cases in the west midlands. Within this area the highest rates

III
ENGLAND AND WALES, 1947-1950
per 1,000,000

1948				1949				1950			
County	C.B.s	U.D.s	R.D.s	County	C.B.s	U.D.s	R.D.s	County	C.B.s	U.D.s	R.D.s
61				264				172			
55	53	54	70	129	68	138	163	152	156	137	272
58	79	58	55	208	113	198	254	204	302	213	159
36	11	32	64	136	155	107	151	134	83	170	141
47	49	35	61	184	170	189	206	425	289	638	362
56	44	75	54	259	329	251	221	136	69	115	185
51	41	51	60	173	159	167	202	223	195	235	218
69		69		179		179		140		140	
63		54	87	215		189	282	151		147	162
97		121	72	136		129	142	172		161	184
60	86	21	53	153	186	125	135	124	93	209	119
94	67	126	71	153	105	188	155	284	153	350	294
0		0	0	209		34	346	90		68	106
97		124	33	189		123	332	146		161	114
63		94	26	91		138	34	68		62	76
73	76	76	58	172	146	171	185	152	123	151	161
43	50	41	41	207	121	218	310	153	123	160	166
28	0	44	32	142	58	153	179	71	58	66	82
87	137	71	61	171	159	154	183	286	201	308	331
49	63	43	47	191	121	209	222	165	132	159	211
121		138	103	205		201	207	205		196	212
77		82	69	255		254	256	430		370	530
47	49	38	54	149	106	149	200	304	201	359	363
57		49	67	340		454	202	287		315	254
85	90	90	79	201	272	165	212	281	155	298	304
73	59	76	74	211	141	235	211	295	191	312	317
70	94	42	40	255	380	168	77	468	605	343	286
40		39	41	181		235	145	315		215	382
55		29	82	41		50	33	220		236	206
39	42	38	30	51	53	54	38	291	213	377	311
29	24	33	27	44	56	47	25	502	769	449	346
61	68	39	43	115	104	153	134	425	472	322	234
52	64	37	43	111	139	88	71	386	438	358	285
57	71	13	73	226	233	292	158	255	367	118	201
156		277	128	231		538	167	369		269	390
50	31	34	74	187	187	234	150	352	293	225	482
44	27	55	53	186	196	182	176	149	176	112	183
46	70	34	48	71	35	45	116	100	139	81	103
49	49	38	63	163	180	166	145	206	252	127	256

were found in the county boroughs, and the towns most affected were Dudley, Bristol, and Birmingham, where the rates were 1,050, 691, and 507 per million.

TABLE

COUNTIES							1947			
							County	C.B.s	U.D.s	R.D.s
NORTH WESTERN	Cheshire	..	..	..	..	..	190	146	178	342
	Lancashire	..	..	..	..	..	214	213	215	221
	..	..	..	..	..	..	209	205	205	266
YORKSHIRE	West Riding	..	..	..	..	..	224	187	268	284
	East Riding	..	..	..	..	..	290	267	325	321
	North Riding	..	..	..	..	..	206	136	92	421
..	..	..	..	..	..	..	230	194	248	322
NORTHERN	Durham	..	..	..	..	..	285	220	333	310
	Northumberland	..	..	..	..	..	231	202	239	305
	Cumberland	..	..	..	..	..	301	108	242	443
..	Westmorland	..	..	..	..	..	367		258	466
..	..	..	..	..	..	..	272	206	294	350
WALES 1	Brecknock	..	..	..	..	..	282		254	294
	Carmarthen	..	..	..	..	..	291		366	236
	Glamorgan	..	..	..	..	..	147	129	134	227
..	Monmouth	..	..	..	..	..	97	109	67	260
..	..	..	..	..	..	..	153	125	134	240
WALES 2	Caernarvon	..	..	..	..	..	89		126	39
	Cardigan	..	..	..	..	..	228		338	172
	Denbigh	..	..	..	..	..	145		171	123
	Flint	..	..	..	..	..	274		376	167
	Merioneth	..	..	..	..	..	130		58	188
	Montgomery	..	..	..	..	..	335		116	473
	Pembroke	..	..	..	..	..	118		123	114
	Radnor	..	..	..	..	..	356		320	372
	Anglesey	..	..	..	..	..	42		0	68
..	..	..	..	..	..	..	173		192	156
TOTAL	..	..	..	..	..	..	221	199	211	239

The distribution of poliomyelitis in some of these localized outbreaks has been quite different from that exhibited by other infectious diseases. Gilloran (1949), investigating the outbreak in Dorset in 1947, found that the better social classes had the highest attack rates, and that in the borough of Poole where the incidence was high the majority of the cases occurred in the better-class residential districts. A similar phenomenon was reported for Luton (Grundy, 1948), where poliomyelitis occurred "in circumstances of good health and low infection—a characteristic of poliomyelitis which seems to favour populations in favourable conditions where the public health services are above the average". Outbreaks in other areas did not show this social distinction. Daley and Benjamin (1948) found an insignificant correlation between the proportion of males aged 14+ who were in social classes IV and V and the attack rates of poliomyelitis in the 28 London boroughs. Hill and

III—continued

1948				1949				1950			
County	C.B.s	U.D.s	R.D.s	County	C.B.s	U.D.s	R.D.s	County	C.B.s	U.D.s	R.D.s
43	47	34	70	114	56	128	204	120	132	123	83
37	40	31	35	109	97	131	103	131	155	96	87
38	41	32	48	110	92	131	141	129	152	103	85
40	35	42	54	220	237	209	171	171	190	123	211
54	65	39	39	91	88	77	113	107	105	126	94
28	63	15	13	63	34	39	115	207	172	187	258
40	41	38	42	188	206	176	148	168	179	132	205
32	23	44	22	45	52	37	49	179	171	194	162
21	28	15	20	124	177	92	40	262	293	194	378
40	46	36	40	135	89	59	209	135	149	118	140
15		32	0	286		189	375	45		31	58
29	26	34	24	85	100	61	106	196	214	183	190
56		63	53	89		234	26	107		176	77
94		153	51	76		85	70	216		310	150
63	85	47	57	103	114	110	60	154	131	131	272
26	29	22	46	85	9	105	138	78	85	76	69
57	75	48	54	96	95	109	68	141	123	129	197
24		42	0	24		28	19	210		183	247
19		0	28	37		108	0	56		0	85
6		0	11	12		26	0	385		348	416
51		43	59	83		99	68	194		141	245
128		0	229	0		0	0	122		57	171
66		56	36	66		0	108	502		669	395
35		48	22	23		24	22	124		118	130
49		0	72	99		154	72	444		463	435
20		0	33	0		0	0	100		104	98
35		27	42	35		44	28	238		214	258
51	48	50	53	157	138	153	151	210	228	186	226

Martin (1949) found no relation between the attack rate of poliomyelitis and the crude death rate from all causes, nor between the attack rate and the infant mortality rate in the 126 large towns and 148 smaller towns, nor between the attack rate of poliomyelitis and the overcrowding index in the London boroughs. Table III shows that, in general, the attack rate in a county is very similar in each density area. In 1950 the correlation coefficient between the attack rates in the urban and rural districts of the counties of England and Wales was 0·75.

SOME EPIDEMIOLOGICAL FACTORS

The spread of infection presents some interesting problems, since poliomyelitis, except in the more advanced stage of the disease, cannot be diagnosed with certainty and many minor attacks probably escape notice or do not require medical attention.

Although in England and Wales the incidence of poliomyelitis has always begun to rise with the advent of warm weather and has reached epidemic proportions in the summer, its relationship to weather conditions is not very definite. The hot dry summer of 1949 might be held to favour the theory of a dust-borne infection, but the larger outbreak in the following year occurred in a wet cold summer.

An important contribution to knowledge of the incidence of the disease in the child population has been made by Casey and others (1950). In a field investigation carried out in Chicago, they showed that subclinical attacks in children were common. Poliomyelitis virus was recovered from the stools of 53 per cent. of contacts (i.e. children living in the immediate neighbourhood of a paralytic case), from 11 per cent. of non-contacts (i.e. children living in the surrounding neighbourhood of the first group), and from 8 per cent. of controls (i.e. children living ten blocks away from the patient with a clinical attack). The authors estimate that probably most children in Chicago had had one subclinical attack of poliomyelitis by their sixth birthday—either different strains or reinfections—and that among Chicago children paralysis was a condition that occurred less than once in 200 cases. We know that trauma can, at least sometimes, affect the course of the disease, for McCloskey (1950) found in Victoria, Australia, that a relation existed in a number of cases between an injection of an immunizing agent and the subsequent development of paralytic poliomyelitis. Hill and Knowelden (1950) found that the distribution of the bodily sites of paralysis was quite abnormal in children who had been inoculated within the month preceding the onset of their illness. In children recently inoculated, the injected limb (arm or leg) was much more frequently a site of paralysis than in children not recently inoculated. Hill and Knowelden concluded “that there may be present in the poliomyelitis group cases which would not have been clinically diagnosed as poliomyelitis at all if their inoculation had not brought them into the paralytic group”. The finding of Casey and his co-workers that poliomyelitis is generally a non-clinical condition from which clinical cases only rarely develop, is in agreement with many of the observed features of the trend of the disease. This would explain the rarity of multiple cases in a family, which has been generally noted in former epidemics, and the larger incidence in the better residential districts, which has been occasionally observed in some local outbreaks. It is well known that with infectious diseases of childhood the age of attack is correlated with density, i.e. children living in overcrowded conditions contract infectious diseases, on the average, at younger ages than their more fortunate brethren living in a better environment. This may well be the case with poliomyelitis; children living in the less congested district of an area may have been subjected to a much smaller risk of a subclinical attack than the remainder, and are consequently much more likely to develop a clinical attack during an outbreak.

The factors which determine whether paralysis develops or not have not been found. The evidence that inoculation can have this effect is fairly conclusive, but this factor can account for only an exceedingly small proportion of the total cases. Exercise in the pre-paralytic stage also appears to be of importance. It has been

shown by several workers that the usual vital statistical indices of general living conditions are unrelated to the level of the incidence rate. Table III does not suggest that any particular area has a peculiar liability to a high incidence rate, nor that a high incidence in one outbreak is necessarily followed by a low incidence in a succeeding outbreak. To examine the latter point in more detail the attack rates in the 28 London boroughs in successive outbreaks were correlated, and the correlations were 0.273 ± 0.175 for 1947 and 1949, and 0.077 ± 0.188 for 1949 and 1950.

Both correlation coefficients are insignificant, and it may therefore be stated that in these areas there was no relation between successive outbreaks.

It also seemed of interest to examine whether the variations in the incidence of acute poliomyelitis between areas were related to the prevalence of other infectious diseases. Accordingly, the notification rates of scarlet fever, whooping cough, diphtheria, and measles in the 28 London boroughs were correlated separately and in total with the notification rates of acute poliomyelitis. (See Table IV.)

TABLE IV
CORRELATIONS BETWEEN ATTACK RATE FROM POLIOMYELITIS AND OTHER INFECTIOUS DISEASES

Year	..	..	..	..	1947	1948	1949	1950
Poliomyelitis and	scarlet fever	..	..	..	0.406 ± 0.16	0.051 ± 0.18	-0.155 ± 0.18	0.522 ± 0.14
	whooping cough	..	..	..	0.175 ± 0.18	0.259 ± 0.18	0.093 ± 0.18	0.027 ± 0.19
	diphtheria	..	..	..	0.735 ± 0.09	0.428 ± 0.15	0.092 ± 0.19	0.040 ± 0.19
	measles	..	..	..	-0.087 ± 0.19	0.053 ± 0.19	-0.006 ± 0.19	0.319 ± 0.17
	combined rate of these four diseases				0.163 ± 0.18	0.134 ± 0.19	-0.002 ± 0.19	0.324 ± 0.17

The incidence of whooping cough and measles was unrelated to the incidence of poliomyelitis in each year, and the distribution of poliomyelitis followed the distribution of diphtheria in 1947 and 1948 and that of scarlet fever in 1947 and 1950. The combined incidence of the four infectious diseases showed no relation to poliomyelitis in any of the four years. Thus it appears that the incidence of poliomyelitis was unrelated to that of the common infectious diseases of childhood.

SUMMARY

The epidemic curve of poliomyelitis in England and Wales during 1947-50 showed considerable annual fluctuations.

In 1947 and 1950 the incidence rose steadily to a peak, but in 1949 the rise was not continuous and the maximum occurred several weeks later. In 1950 the rise in incidence began about a month earlier.

For England and Wales as a whole there is no evidence that the towns have a greater liability than the rural districts. The disease was more widely scattered in 1950 than in former years of high incidence, although in 1949 the northern counties and Wales had a relatively light experience.

The area incidence of successive outbreaks did not appear to be related.

In the London boroughs the incidence was not related to that of infectious diseases of childhood.

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