THE MILROY LECTURES ON CHANGES OF TYPE IN EPIDEMIC DISEASES.

Delivered at the Royal College of Physicians.

By B. ARTHUR WHITELEGGE, M.D., B.Sc.,
Medical Officer to the County Council of the West Riding of Yorkshire.

LECTURE II.

*Diseases of More Stable Type.—Evidence of Change.—Scarlet
Fever.—Small-pox.—Measles.*

It has long been recognised that scarlet fever changes greatly in character, and that while some epidemics are mild, others are severe. In Sydenham's time it was persistently mild. In Dublin, from 1804 to 1834, the epidemics of scarlet fever were of non-fatal type, but after, as well as before this period, they assumed a malignant form.

In New York the scarlet fever death-rate, after being low for thirty years, suddenly increased tenfold in 1828-9, and remained high for sixteen years. Very many instances of this kind are on record, but, nevertheless, they are exceptional, and, as a rule, the changes in type, which are neither rare nor unimportant, are of slower and more orderly character.

The scarlet fever death-rate in London for the last fifty years presents many points of interest. At intervals of about five or six years wave after wave of high mortality is seen, alternating with depressions corresponding to years of low mortality. The rise and fall are gradual, a maximum in one year being rarely followed by a minimum in the next. This at once suggests that the variable factor, whether prevalence or severity, or both, rises by degrees to a maximum, and then falls by similar degrees to a minimum, usually to rise again as before. But there is a further point. There are indications of a tide in the series of waves. The highest mark was reached in the "sixties," and since that time the successive crests have been lower and lower. During the last ten years the mortality has been persistently low, and the orderly sequence of epidemics is scarcely traceable. Presently we shall see that the average case mortality rose and fell with the recorded death-rate, so that the type was most severe when the recorded mortality was highest. A study of the records of other parts of the kingdom shows that, while an interval of five or six years is by far the most usual, it is by no means universal or even constant in the same locality.

The course of scarlet fever mortality for England as a whole is very similar to that of London. In the "sixties" there were bold waves of high mortality, subsiding gradually into a comparatively even course in the "eighties," with low death-rates. It seems, therefore, that under the conditions then prevailing most parts of the country must have suffered from scarlet fever, not only at similar intervals, but in the same years. As the average mortality grew less in the "seventies" and "eighties," the irregularities became more prominent in the curve for England than in that of London. The outbreaks in different parts of the kingdom became less synchronous.

Many local records show little tendency to rhythm, others a well-marked succession of waves, with occasional irregularities. Nearly all exhibit the same decline in the last decade, with a tendency to lengthening of the interval, and more or less complete loss of rhythm. At Bristol epidemics occurred in 1863, 1870, 1875, 1880, and 1887, the loss of life being less and less at each outbreak, and least of all, there-

fore, after the longest interval. At Swansea the intervals were five, five, six, and nine years; and again the least destructive epidemic followed the longest interval, so that accumulation of susceptible persons can scarcely have been the principal influence at work. In Wolverhampton and Sheffield a four-year interval seems to have prevailed.

Mortality records therefore teach that scarlet fever is a declining disease, and that with its decline there is a tendency to localisation, lengthening, lowering, and even disappearance of the epidemic waves. We have next to inquire whether the alternations of high and low mortality were due to changing prevalence, changing severity, or both. The records of notification towns prove that the case mortality fluctuates in a very remarkable way. At Nottingham notification began in 1882, after a severe epidemic which reached its height in 1881. The record is not long enough to show how the case mortality curve would run at the outset of a new epidemic, but it does show that with the decline of mortality there has been a decline in the average severity of attack. From 1858 to 1882 epidemics occurred at the usual interval of five or six years, but since 1882 there has been no year of high mortality, and the epidemic rhythm has abruptly ceased. These changes have been accompanied by uniformly mild and non-fatal type of disease, although the prevalence has in some years been considerable.

The Christiania records of scarlet fever cases and deaths are given by Johannessen¹ for the years 1863-78, and although not extensive, they may serve to illustrate certain points.

—	Attacks.	Deaths.	Case Mortality.
1863	216	47	21.8
1864	28	1	3.6
1865	21	1	4.8
1866	171	19	11.1
1867	705	159	22.6
1868	228	68	29.8
1869	287	36	12.6
1870	896	70	7.8
1871	244	24	9.8
1872	24	2	8.3
1873	29	3	7.7
1874	115	12	10.4
1875	1,030	156	15.1
1876	1,111	241	21.7
1877	214	62	29.0
1878	162	33	20.4

The mortality curve ran high in 1867 and 1875-6, with minor elevations in 1863 and 1870. The attack curve is irregular. There was great prevalence in 1867 and 1865-6, as would be inferred from the death curve, but there was also an excess of attacks in 1870, which produced comparatively little effect in the death-rate. The case-mortality curve is much more orderly, and shows a maximum severity in 1867-8, and 1865-6-7. Between these periods it fell, and the intercurrent prevalence of 1870 was attended with a lower case mortality than the years preceding or following it. It was therefore a wave of prevalence merely, due perhaps to exceptional meteorological conditions; not due at all events to any increased potency of the disease, or intensification of type. Under such conditions the case mortality is always lowered, for reasons which will become apparent presently. In Christiania the salient features of the death curve are primarily related to changes in case mortality, although changes in prevalence accompany these for the most part. Increased case mortality seems always to carry with it increased prevalence, but there may be, as in 1870, prevalence without increased severity.

Evidence of another kind may be obtained by comparing the case mortality among hospital patients with the death-rate of the community from which they are drawn. The scarlet fever case mortality in the London Fever Hospital from 1832 onwards shows a tolerably steady rise and fall, with wave lengths of about five or six years, and moreover this rise and fall is at nearly all points parallel with that of the London scarlet fever mortality, especially during the period from 1859 to 1880. From 1872 onwards the statistics of the Metropolitan Asylums Board Hospitals are available.

¹ Die epidemische Verbreitung des Scharlachfiebers in Norwegen.

*Scarlet Fever, London.**

	Scarlet Fever Death-rate, London.	Case Mortality.	
		London Fever Hospital.	Metropolitan Asylums Board Hospitals.
1859	1.28	11.7	—
1860	0.73	11.0	—
1861	0.85	12.3	—
1862	1.22	12.8	—
1863	1.71	16.0	—
1864	1.10	16.0	—
1865	0.73	13.2	—
1866	0.62	10.3	—
1867	0.47	6.7	—
1868	0.93	10.2	—
1869	1.84	15.3	—
1870	1.88	13.2	—
1871	0.58	12.5	—
1872	0.28	9.1	10.8
1873	0.19	6.8	6.6
1874	0.77	10.5	12.2
1875	1.10	12.8	13.7
1876	0.65	11.4	12.1
1877	0.44	9.6	12.1
1878	0.50	12.2	14.3
1879	0.72	13.0	15.3
1880	0.82	11.3	12.3
1881	0.55	10.4	11.1
1882	0.52	8.8	10.4
1883	0.51	10.9	12.4
1884	0.36	10.8	12.3
1885	0.18	8.3	9.5
1886	0.17	7.5	9.0
1887	0.36	7.9	9.5
1888	0.30	2.3	9.9
1889	0.19	1.2	8.9
1890	0.21	2.3	7.9
1891	0.14	0.9	6.7

* The death-rates are taken from the Registrar-General's annual reports; the Metropolitan Asylums Board statistics from the annual reports of the Metropolitan Asylums Board; and the London Fever Hospital data were kindly furnished by Dr. Hopwood.

In the eighties both curves decline, and in declining lose their rhythm. In the Metropolitan Asylums Board hospitals the patients are drawn from a different class, and the case mortality has declined much less rapidly. It is noteworthy that the indication of the old rhythm is better preserved in the severity curve of these hospitals than in the other, a further illustration of the fact that loss of rhythm and decline of severity are in some way bound up together.

Here again the mortality curve is seen to be moulded primarily on that of severity, and as long as the severity runs high the mortality curve is closely parallel with it. When, however, severity declines to a low level, its slight variations are no longer traceable clearly in the death curve, being obscured by the sharp and irregular variations in prevalence due to season, or accident, or accumulation of susceptible persons. Other things being equal, the maximum prevalence will naturally occur at the periods when the disease is of most virulent and most highly infectious type; but as other things are not always equal, epidemics occur at other times too.

It may be suspected that the epidemic rhythm is still maintained, though too faintly to be detected by such crude tests as case mortality or death-rates, and that it will reassert itself if and when the type of scarlet fever again becomes more severe. On the other hand, it seems clear that there is nothing essential or permanent in the length of the usual five or six years cycle, since it is often extended or shortened, and we have no grounds for fixing limits in either direction. It is possible too that the persistent removal to hospital of the most virulent cases has had something to do with the present low average of case mortality: not merely by increasing the chances of recovery, but also by leaving only the milder attacks to propagate their kind by diffusing infection. But here again it must be remembered that the attenuation began before isolation assumed large proportions, and has not been altogether limited to the towns in which isolation has been practised. In former years, too, long intervals of low intensity have been recorded, but have not proved permanent.

In manufacturing and mining districts high intensity has

sometimes prevailed for a long term of years, although not without some indication of the usual rhythm. In such districts the centres of population are near together, the intercommunication is free, and the birth-rate is high. These circumstances may be regarded as conducive to sustained prevalence of scarlet fever.

It seems then that when the scarlet fever mortality curve rises at more or less regular intervals, it does so for two reasons: because the attacks are more numerous, and because they are more fatal in type. They are more numerous because there is increasing power of overcoming resistance whereby those who were safe during the interval become more and more liable to attack; because the severer cases are more capable of diffusing infection; because the wider diffusion thus brought about lessens the chance of susceptible persons escaping; and lastly, because the susceptible population has to some extent been reinforced during the years of comparative freedom from scarlet fever. After reaching its acme, the death curve descends again for a year or two to a new minimum. It descends because there is a less susceptible population, less infectiveness, and less fatal type. The attacks, while lessening in number, lessen in severity also; and as they are both fewer and milder, the death-rate falls in compound ratio.

Vaccination has profoundly affected the epidemic course of small-pox, but changes of type are evident. In the latter part of the last century, small-pox contributed on an average about one-tenth of the whole death rate of London; in 1796 no less than 18.3 per cent. After this and coincidentally with the introduction of vaccination its ravages lessened, until 1830. From 1830 to 1838 the records are missing, but in 1838 the mortality was again comparatively high, though below even the average which prevailed half a century before. After 1838 we can measure its course by actual death-rates, and a considerable degree of order, and even rhythm becomes apparent. Every few years—usually four or five, but sometimes two or three only—it recurred as an epidemic, but with somewhat reduced destructiveness each time, until 1855, which happened to be half way between 1838 and 1871. After 1855 minor epidemics continued to recur at about the same interval, but the loss of life on each occasion increased rather than otherwise. Then came the great epidemic or pandemic of 1871, killing a larger proportion of the population than in 1838. The course of events for twenty years after 1871 was not unlike that which followed the 1838 epidemic; successive outbreaks at intervals of four or five years, decreasing in mortality and subsiding after 1885 to a much lower level than was ever before reached.

Among unprotected persons the case mortality even now runs high, but small-pox of to-day is evidently different from that of 1871—different in virulence of attack, and still more different in infectiveness and power of epidemic diffusion. The last-named tendency especially seems to have been at a low ebb in 1888-90 as in the "fifties," and we may not unreasonably anticipate in the "nineties" the same sort of gradual intensification which occurred in the "sixties."

In considering the English epidemic of 1871 as part of the great pandemic which about that time overran Europe, we must not lose sight of the fact that for several years previously there had been indications of increasing intensity in London, that is, a tendency to slightly greater destructiveness in each successive minor epidemic. The same may be said of Prussia and Austria.² In Prussia small-pox was epidemic in 1841-2-3, 1853-4, and 1864-5-6-7, recurring at intervals of about eleven years, and with steadily increasing intensity. Then after an interval of only five years came the pandemic of 1871-2, which (as in England) was much more destructive than the other terms of the series would have led us to anticipate; but, apart from the pandemic, a formidable outbreak would have been due in 1876.

Whether the minor epidemics which occurred in London at intervals of four or five years were attended with any temporary increase of severity, as in scarlet fever, is a point of considerable doubt. Some indication of such a change is afforded by hospital statistics, though not very clearly. It has been observed that during the rise of a minor epidemic malignant and hæmorrhagic cases are more often met with than

² Report of the German Vaccination Commission, 1884. A summary is given by Dr. E. J. Edwards (*Epid. Soc. Trans.*, 1885-6).

they are later on, and at the decline of those outbreaks infectiousness appears sometimes to be almost lost, even though virulence shows but little change. In May, 1884 (as in January, 1881) acute cases of small-pox were aggregated at the Fulham Hospital. Mr. Power found that this was followed by excessive incidence of small-pox upon the surrounding population, that the infection was in all probability airborne, and that the meteorological records were of a character which seemed favourable for the aerial diffusion of particulate contagia. But in June and July, 1884, with greater accumulation of acute cases in hospital, and apparently similar weather indications, there was little if any evidence of diffusion. Hence Mr. Power infers that the quality or infectiveness of small-pox itself may have changed in the interval. Another possibility would seem to be that the atmospheric states suited for such diffusion may include as an essential element some detail (perhaps purely local) not indicable in the rough data of ordinary meteorological readings, which are, in truth, only daily averages and daily samples of conditions incessantly changing. Some limitation of the power of diffusion of infection must occur normally about June, for the average seasonal curve of mortality begins to decline sharply at that time. Presently it will be seen that this decline is attended with increased case mortality.

There has been some prevalence of small-pox in Yorkshire during the past two years, attended in many districts with certain anomalies of type; for example, an occasional interval of only twenty-four hours between a definite onset and the appearance of rash, and sometimes an equally short interval between the first appearance of the rash and its attaining the vesicular stage. For the most part the aberrant types were slight and non-fatal, but this was not always so, nor were they limited to vaccinated persons. In one district at least the comparatively rare complication of pneumonia was met with in a considerable portion of the attacks. It would be interesting to know whether irregularity of type has been observed in other parts of the country recently, and whether anything of the kind was noticed at the corresponding period of forty years ago.

To sum up, the type of small-pox seems to be stable, rising and falling in intensity if traced through long periods of years, the intensity being indicated even more by power of epidemic diffusion than by severity of attack. But, apart from these long cycles, there is a tendency to shorter cycles of four years or so, which may or may not prove to be accompanied by temporary increase of intensity, and are probably governed by the accumulation of susceptible persons and other external conditions. Lastly, there are seasonal changes regulated by the facilities for diffusion, and not attended by any change of intensity.

Measles presents many points of analogy with small-pox. They are alike in their independence of soil, water infection, and milk infection, in their relations to age and sex, in the duration of the intervals between infection and attack, and also between onset and appearance of rash, and in the primary seat of eruption. As regards the seasonal curve, they have at all events the autumnal minimum in common. They are not unlike in the evidence which they afford of comparative constancy of type. Notwithstanding the scantiness of the records, alternate increase and decrease in virulence can be traced in many localities, each wave lasting often twenty years or more in this country, although perhaps less elsewhere. As in small-pox, the rise and fall of the broad primary curve is interrupted, in a sense mechanically, at short intervals by explosions occurring when the accumulation of susceptible persons is sufficient, and the climatic and other external conditions offer sufficiently small resistance. These outbursts of measles are often of brief duration, and terminate as soon as the balance among the conditions promoting and inhibiting the spread of infection inclines sufficiently far in the direction of the latter. The interval is variable, but in English towns is usually about two years.

The exact time of outburst is evidently affected by climatic conditions; and as the mean seasonal curve shows two maxima—two points of least resistance six months apart—it is not surprising to find that the interval when not exactly two years is frequently one and a half or two and a half years. There is, however, no assured constancy in the balance of influences upon which the interval depends, and it is often

reduced to one year or extended to three or four. In Sweden³ and Norway⁴ six or seven years usually elapse between successive outbreaks, and in Norway, at all events, there is evidence of higher case mortality accompanying each epidemic. The brief biennial explosions familiar in this country do not appear to be attended by increased case mortality. Their type is that of the prevailing phase of a broader wave. The bills of mortality show that about 1800 the average measles mortality in London began to increase, reaching a maximum about 1815. The Registrar-General's *Reports*, from 1838 onwards, show a distinct rise and fall in London measles mortality, with maxima in the early forties, in the sixties, and in the eighties, over and above the biennial rhythm already referred to. It is difficult to account for these long waves without assuming some altered quality of measles, and the more detailed records of certain provincial towns leave little room for doubt upon this point.

At Sunderland⁵ in 1885 a virulent epidemic prevailed, causing in one quarter a mortality equal to an annual rate of 9 per 1,000 from measles alone. The recorded case mortality was 29 per cent. Looking to the records of former years, it is seen that from 1875 onwards there were biennial explosions, increasing progressively in destructiveness, and culminating in the exceptionally malignant outbreak already referred to. Since 1885 epidemics on a declining scale have occurred at similar intervals. It would seem that the quality of measles underwent progressive changes, from a minimum intensity in 1875 to a maximum in 1885, and that the course from 1875 to the present time is, in a sense, one great wave, interrupted repeatedly in a mechanical fashion by the temporary exhaustion of the susceptible and by other external conditions.

In 1889-90 a severe epidemic prevailed at Hanley, and was investigated by Mr. Spear.⁶ He found that the symptoms were of aggravated type, and the case mortality not far short of 9.0 per cent. On reference to the Registrar-General's returns for previous years, we find that in the districts most severely affected there had been a succession of outbreaks, at not very regular intervals, but steadily increasing in mortality until, as already seen, there came an epidemic conspicuous above the rest for its severity of type as well as high mortality. A third example, in one respect more complete, is afforded by Barnsley. An exceptionally severe epidemic took place early in 1891. It had been preceded by other outbreaks in 1881, 1883, 1886, and 1888, at intervals of about 2½ years. The measles death-rate increased with each successive epidemic, and Dr. Sadler, medical officer of health for the borough, observed that, at all events in the last three epidemics of the series, the type grew more and more severe, each exhibiting higher infectiveness and wider extension than its predecessor. The change of quality in these instances seems clear, and a similar change may be inferred with more or less probability from the course of the measles death-curve in London, Wolverhampton, and many other towns.

The case mortality in measles is greatly influenced by surroundings, the severity and fatality being greatest among the poor. The experience of epidemics among soldiers in time of war seems to confirm this. In Fiji in 1875 the case mortality was enormous, and almost all the population, young and old, were attacked; but here not only neglect and exposure of the sick, but exceptional susceptibility of a population never before invaded by measles, have to be taken into account. The resistance was therefore lessened in two ways. Whether the destructiveness of the pestilence was to be attributed entirely to this lowered resistance, or whether there was an increased intensity of the contagium—in other words, a true change of type—remains to be proved.

³ Arthur Ransome, M.D., *Epid. Soc. Trans.*, 1881-2.

⁴ Johannessen, *loc. cit.*

⁵ Annual Report of Medical Officer of Health for Sunderland, 1885.

⁶ Annual Report of the Medical Officer to the Local Government Board, 1890.

DR. J. J. REINCKE, who has discharged the duties of Medical Inspector, that is to say, Head of the Sanitary Department of Hamburg since the retirement of the late Dr. Kraus, has now been formally appointed to the post.

THE Chancellor of the Duchy of Lancaster has appointed Dr. Wm. Graham to be a justice of the peace for the borough of Middleton.