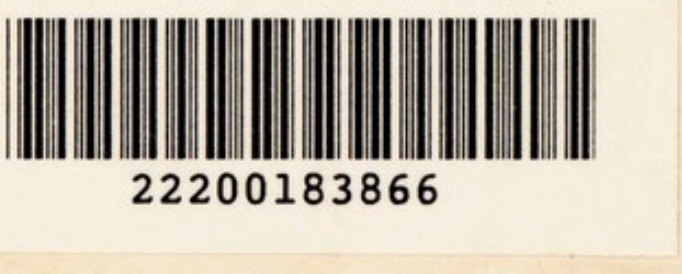
Half a century of small-pox and vaccination : being the Milroy lectures delivered before the Royal College of Physicians of London on March 13th, 18th and 20th, 1919 / by John C. McVail.

HALF A CENTURY OF SMALLPOX AND VACCINATION

John C. McVail



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OF

SMALL-POX AND VACCINATION

BEING

The Milroy Lectures delivered before the Royal College of Physicians of London on March 13th, 18th and 20th, 1919.

BY

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EDINBURGH:

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PREFACE.

THESE lectures have been carefully revised for publication, but alterations and additions have been kept within narrow limits. The amount of time and attention which in the course of his life the author has given to Small-pox and Vaccination is indicated by the subjoined note of previous work. The present is probably his final contribution to the study of the subject. In that view he has endeavoured in the first lecture to survey shortly the statistical and epidemiological history of Small-pox in modern times. Much of the second lecture is devoted to rebutment of a contention that infantile vaccination, whilst protecting the individual, makes Small-pox so mild and so difficult to recognize where it is not entirely prevented, that the result is such spread of infection from missed cases as to render the practice, on balance, disadvantageous to the community. The final lecture gives an account in considerable detail of the measures of prevention and control which, in the absence of systematic vaccination and re-vaccination, ought, in the author's judgment, to be adopted when the disease appears in this country in the present day. He regrets that the first lecture is so abundantly statistical, but the figures are necessary to establish the thesis that natural Small-pox gradually increased in virulence in the course of the eighteenth century, reached its maximum of fatality and infectivity in the Pandemic of 1870-73, and since that time has retrogressed alike in fatality,

infectivity, and prevalence. What the future may have in store, whether of reversion to virulence or of progress towards disappearance, no man can tell, but an attempt has been made in the lectures to record briefly and accurately the general course of events up to the present time.

EDINBURGH, September, 1919.

NOTE OF PREVIOUS WORK.

1. Small-pox in Kilmarnock in the Eighteenth Century (*Trans. Phil. Soc.*, Glasgow, 1882, and Fourteenth Report of the Medical Officer of the English Local Government Board, 1884.)
2. *Vaccination Vindicated.* (Cassell & Coy., 1887.)
3. Dr. Creighton on Vaccination. A Review. (*Edinburgh Medical Journal* 1889-90, and Jenner Society's publications.)
4. Evidence before the Royal Commission on Vaccination, 1892-3. (Sixth Report of the Commission.)
5. Small-pox and Vaccination. (Stevenson & Murphy's *Treatise on Hygiene*, Vol. II. Churchills, 1893.)
6. The Aërial Convection of Small-pox from Hospitals. (*Trans. Epidem. Soc.* Vol. XIII, 1894.)
7. Cow-pox and Small-pox—Jenner, Woodville and Pearson. (Jenner Centenary Number of the *British Medical Journal*, Vol. I, 1896.)
8. Sanitation or Vaccination. A Glasgow Study. (*Public Health*, 1896.)
9. Leicester and Small-pox. (*Lancet*, Vol. II, 1897, pp. 1341, 1405, 1475, 1691.)
10. A Review of the Statement of Dissent from the Report of the Royal Commission on Vaccination. (*Trans. Epidem. Soc.*, Vol. XVI, 1897.)
11. Gloucester and Small-pox. (*Lancet*, Vol. I, 1898, pp. 529, 597, 807 and 886.)
12. Contribution to a Discussion on the Spread of Small-pox from Hospitals. (*Trans. Epidem. Soc.*, Vol. XXIV, 1904-5.)
13. Vaccination as a Branch of Preventive Medicine (Allbutt & Rolleston's *System of Medicine*, Vol. II, 2nd edition, 1906, Macmillan.)
14. Vaccination and the Control of Small-pox (*The Practitioner's Encyclopædia of Medicine and Surgery*, 2nd edition. Oxford Medical Publications, 1913.)

CONTENTS.

HALF A CENTURY OF SMALL-POX AND VACCINATION.

Lecture I.

INTRODUCTORY.

In beginning these lectures I crave permission to strike a personal note. It happens to be just fifty years since I entered on the study of medicine at the old College of Glasgow. The pandemic of small-pox which had started before, but was greatly favoured by the Franco-Prussian war, reached Glasgow in 1871. At first some cases of the disease were treated in the Fever House of the Royal Infirmary, so that students had opportunity of seeing small-pox in the wards, though spread of infection among patients soon caused its exclusion. In 1873–74 the epidemic reached the town of Kilmarnock in Ayrshire, where I had just begun practice and where the outbreak could be watched from beginning to end. A few years later my interest was stimulated by the discovery of a local register of mortality covering the period 1723 to 1764. Publication of the facts as to the ravages of small-pox revealed in this record led to further discussion of the whole subject which again resulted in my giving lengthy evidence before the Royal Commission on Vaccination. Also, as Medical Officer of Health for Kilmarnock and subsequently for the counties of Stirling and Dunbarton, various opportunities of dealing with the disease, especially from the preventive and administrative sides, fell to my lot, and now my thanks are due to the Royal College of Physicians for giving me the opportunity, through the Milroy Lectureship, of endeavouring to sum up the opinions or conclusions

which have formed themselves in my mind in the course of these fifty years.

It will be convenient to treat the subject in three sections, each constituting a lecture:

I. Small-pox as it was and is.
II. Vaccination as it was and is.
III. Control of small-pox in the present day.

I. SMALL-POX AS IT WAS AND IS.

How does the small-pox of the present compare with the small-pox of the past in respect of (*a*) fatality, (*b*) infectivity, and (*c*) prevalence?

(*a*) Fatality.

The literature of small-pox in the days before vaccination depicts it as a disease of normally high fatality, with occasional outbreaks of a very mild character. Wagstaffe's statements: "There is scarcely, I believe, so great a difference between any two distempers in the world as between the best and worst sort of small-pox"; and "there is one sort in which a nurse cannot kill, and another which even a physician can never cure,"[1] may no doubt be explicable on the supposition that he did not distinguish between variola and varicella. Even Sydenham's reference to variolous fever without eruption might be attributed to his theory of epidemic constitution of the atmosphere having caused him to regard febrile illness during an acknowledged small-pox epidemic as due to the existing atmospheric constitution. Such terms as windpock, water-pock, stonepock, swinepock, and nirlepock, may often have meant small pox much modified, though not absolutely prevented by previous inoculation. There is, however, unquestionable evidence of exceptional mildness of type in the small-pox of 1789, which Jenner proposed to utilize for establishing a mild sort of inoculation, milder even than the Suttonian then in vogue. Also, in 1806, Adams of the Small-pox Hospital in London gave the name pearl-pox to a much modified variety which then prevailed.

Prior to the Acts for notification of infectious diseases (adoptive in 1889, compulsory in 1899) fatality rates in

modern times are to be learned mainly from hospital practice, and those which I am about to give include both vaccinated and unvaccinated. Until the pandemic of 1870–73, for hospital statistics in this country we have to depend on the London Hospital for Small-pox and Vaccination, which originated in 1746 as the Hospital for Small-pox and Inoculation.

In 1836–51 Marson at that hospital had 5,982 cases with 1,279 deaths, or 21.38 per cent.

This period includes the first of the two greatest epidemics of the nineteenth century—those of 1837–41 and 1870–73. Marson's predecessor, Dr. George Gregory, records for the epidemic year 1838 694 cases with 188 deaths, or 27.1 per cent.[2]

The European Pandemic of 1870–73.

By 1870–73 the practice of vaccination in Britain had greatly extended, and affected the gross fatality rates.

The first hospital of the Metropolitan Asylums Board was opened at the end of 1870, and the following rates are given:

Metropolitan area, 1870-72: Number of cases, 13,721; deaths, 2,557=18.6 per cent.

Glasgow in 1871–74[3] had 4,328 cases, with 786 deaths=18.1 per cent.

In Cork Street Hospital, Dublin, in 1871–73 there were 746 cases, with 162 deaths=21.6 per cent. In the same institution in four years beginning April 1st, 1876, the figures were: 2,404 cases, 523 deaths=21.7 per cent.

Between the pandemic of 1870–73 and the epidemic of 1892–95 about to be considered, mention may be made of two local epidemics:

Sheffield, in 1887–88, had 4,677 cases, with 474 deaths =10.1 per cent.

Bristol, in the same period, with 327 cases, had 37 deaths =11.3 per cent.

The Epidemic of 1892–5.

The epidemic of these years was of wide extent. In the Metropolitan Asylums Board's institutions there were in 1893–94: 3,493 cases, with 282 deaths=8.1 per cent. If the four years 1892–95 be taken instead of the two years 1893–94, the fatality rate is almost identical: 4,759 cases, 381 deaths=8 per cent.

The following figures relate to outbreaks in various places in the provinces. The disease prevailed chiefly in Lancashire and Yorkshire, but also further south. There was in addition considerable prevalence in Scotland and Ireland.

TABLE I.

Small-pox Fatality Rates.—Provinces.

Epidemic 1892-95.

Place.	Time.	Cases.	Deaths.	Percentage.
Middlesbrough ...	1893-4	115	11	9.6
Liverpool	1892	194	15	7 7
Manchester	1892-4	996	68	6.8
Salford	1892-5	173	22	12.7
Warrington	1892-3	598	60	10.0
Oldham	1894	165	22	13.3
Halifax	1892-3	513	44	8.6
Bradford	1893	935	100	10.7
Hull	1893-4	205	12	5.9
Leeds	1893	586	30	5 1
Brighouse	1892-3	150	18	12.0
Sheffield...	1892-4	157	9	5 7
Keighley	1893	72	7	9.7
Derby	1893 and 1895	135	15	11.1
Nottingham	1893	53	6	11 3
Leicester	1892-3	347	21	6.1
Hinckley	1894	118	10	8.5
Birmingham	1893-5	3,153	248	7.9
Aston Manor	1893-4	315	29	9.2
Walsall	1893-4	945	83	8.8
Willenhall	1894	842	47	5.6
Bristol	1893-4	366	36	9.8
St. Albans	1893	58	6	10 4
Edinburgh	1892-5	697	73	10.5
Glasgow...	1892-5	750	58	7.7
Dundee	1892-5	22	2	9.1
Rest of Scotland ...	1892-5	443	34	7.7
Dublin (Hospital) ...	1894-5	796	96	12.1
		13,899	1,182	8.5

The fatality rates in London and the provinces are so approximately equal in the early nineties as to show that the same general type of disease prevailed throughout the country as a whole. This was the first extensive epidemic since the seventies, and small-pox showed itself a much less fatal disease.

The Epidemic of 1902-5.

We come now to the most recent extensive prevalence of small-pox in Britain, and that is so long ago as 1902-5.

Summarizing the London statistics from 1870 to 1902 the Metropolitan Asylums Board has recorded for the sphere of its own operations fatality rates as follows:

1870–72	...	...	...	...	18.8 per cent.
1876–78	...	...	...	...	18.2 ,,
1879–83	...	...	...	...	16.5 ,,
1884–85	...	...	...	...	15.9 ,,
1892–93	...	...	...	...	8.0 ,,
1901–2	...	...	...	...	16.8 ,,

The data on which these rates are based are:*

Period.				Cases.		Deaths.
1870–72	...	...	...	13,721	...	2,557
1876–78	...	...	...	13,208	...	2,410
1879–83	...	...	...	14,558	...	2,329
1884–85	...	...	...	12,509	...	1,992
1892–93	...	...	...	3,493	...	282
1901–2	...	...	...	9,659	...	1,629

It will be at once observed that the progressive decline in fatality which had gone on from 1870–72 to 1892–93 was abruptly broken in 1901–2 in London. The data are: 9,659 cases, 1,629 deaths = 16.8 per cent.

In Middlesex in 1901–2 the disease was of the London type, thus: 1,868 cases, 301 deaths = 16.1 per cent.

In the Provinces.

At this time the Local Government Board were obtaining from London and from nearly all provincial towns of over 25,000 inhabitants, as well as from others of smaller population, weekly returns of notifications, and issuing a weekly statement to the medical officers of the towns taking part in the scheme. The aggregate population thus dealt with altered as the returns increased, but the total (including London) was between 19 and 20 millions of the 32 millions in England and Wales. In the provinces in 1902–6 inclusive the cases thus reported were 23,883 and the deaths 1,649, or 6.9 per cent.

* If 1870–73 be taken instead of 1870–72 the figures are: 16,080 cases, 3,024 deaths = 18.8 per cent.; and if 1892–95 be taken instead of 1893–94 the statistics are: 4,759 cases, 381 deaths = 8.0 per cent. There is a slight discrepancy as to the 1870–72 rate; the data give 18.6 not 18.8 per cent.

Turning now to detailed statistics of the provinces for this epidemic, I have gathered from various sources the data of many outbreaks from 1900 to 1906, according to

TABLE II.

Small-pox Fatality Rates.—Provinces.

Epidemic 1902–5.

Place.	Time.	Cases.	Deaths.	Percentage.
Newcastle	1903–5	628	28	4.5
Tynemouth...	1902–5	328	17	5.2
Chester-le-Street	1903–4	106	6	5 7
Wigan	1902–3	70	1	1.4
Blackburn	1902–3	141	5	3.5
St. Helens	1902–5	66	3	4.5
Sunderland	1902–3	66	4	6.1
Liverpool	1902–3	2,280	159	7.0
Manchester	1902–4	563	33	5.9
Salford	1902–4	262	12	4.6
Preston	1904–5	172	8	4 7
Macclesfield	1903–4	69	5	7.2
South Shields	1902–5	272	14	5.1
Oldham	1902–3	413	32	7.7
Chadderton...	1902–5	144	5	3.5
Stockport	1902–4	159	15	9.4
Warrington...	1903	86	4	4.7
Heckmondwike	1904	91	5	5.5
Batley...	1904	103	6	5.8
Dewsbury	1904	552	57	10.3
Bradford	1901	28	0	0.0
Halifax	1903	141	6	4.3
York	1902–4	39	7	17.9
Leeds	1902–5	690	35	5.1
Hull	1903–4	184	10	5.4
Sheffield	1902–4	141	5	3.5
Derby...	1903–4	255	5	2.0
Nottingham...	1903–5	479	17	3.5
Bristol	1903–6	125	4	3.2
Birmingham	1902–5	364	17	4.7
Leicester	1902–4	731	30	4.1
Cardiff	1901–5	96	5	5.2
Swansea	1902	187	33	17.1
Portsmouth...	1902–5	20	1	5.0
Ilford	1900–4	82	9	11.0
County Palatine of Lancaster	1902–6	2,502	118	4.7
Durham County	1902	35	1	2.9
West Riding (including Dewsbury)	1903–4	3,296	215	6.5
Northamptonshire ...	1902–3	44	9	20.5
Ossett Union	1902–3	519	61	11.8
Nottinghamshire	1903–5	376	14	3 7
Edinburgh	1900–4	191	16	8.4
Glasgow	1900–2	2,255	283	12.5
,, ...	1903–4	1,158	88	7.6
Dundee	1900–4	175	12	6.9
Rest of Scotland	1900–4	2,844	235	8.3
Dublin (Hospital)... ...	1903–4	243	33	13.6

the spread of the disease in different localities. Table II records the figures. It will be seen that, as contrasted with London's reversion to a higher fatality rate, there was a further and appreciable decline from 1892–95, many

of the rates being round about 5 per cent., and several well below that figure—even 2, 3 and 4 per cent.

These facts, with due reservation for vaccination and diagnosis, show unequivocally a milder epidemic type in the provinces at this period than had been known since reliable statistics on any extensive scale became available.

In the metropolitan area itself in 1903 there was some prevalence, not, however, by extension from 1901–2, but by infection from the provinces and elsewhere. The cases were 355, and, allowing for a few remaining in the wards at the end of the year, the fatality rate was only 3 per cent. In Middlesex at this time the disease was no less mild, there having been in 1903–5, 185 cases with 5 deaths, or 2.8 per cent.

Clinical Observation of Small-pox.

The tables of statistics which I have submitted do no more than support clinical observation of the change that has taken place in small-pox. They are a convenient method of setting forth broadly what every physician whose experience of the disease goes back far enough has with his own eyes seen of the contrast between past and present. And even so, some small reservation as to change of type has to be made in accepting the teaching of the statistics. Comparison of fatality rates at the present day with those of (say) only twenty or thirty years ago must be affected by the fact that systematic contact hunting brings out many very slight cases which but for the hunting would not be discovered at all. In these days such cases are notified and go to hospital, and increase the quantum of mild cases. Similarly, the contact hunting produces a large number of cases vaccinated just too late for complete protection, but greatly modified by the vaccination after exposure. This must now be a common experience where sporadic groups are being dealt with in towns and in factories and workshops. The result is also to increase the total of the mild cases in hospital, and so affect the fatality rates.

Two Types—Severe and Mild.

Concerning the sources of the two different types of small-pox occurring simultaneously in Britain in the epidemic years following the beginning of the twentieth century, it is necessary to look abroad for enlightenment. Fortunately, since I began to prepare these lectures, the Local Government Board has published an invaluable collection of statistics by Dr. Bruce Low relating to small-pox in many parts of the world, and so I am able to put aside in favour of his authentic official figures much material which I had been laboriously collecting.

European or African Type.

Dr. Bruce Low's report (p. 26) shows that in France after a period of comparative quiescence in 1897–99, small-pox became active in the years 1900–1903. In Paris in 1900–1 there were 4,505 cases, with 758 deaths, or 16.8 per cent. This happens to be exactly the London fatality rate of the same period, and in his report for 1902 to the London County Council Sir Shirley Murphy says (p. 28); "In summary it may be stated that during 1900 and 1901 small-pox had been frequently introduced into London from abroad, especially from Paris." Paris and Marseilles were the chief centres for spread of infection in France at this time, there having been in 1899–1900 more than 1,000 deaths in Marseilles. Spain also was heavily attacked by small-pox in 1900–1903. Madrid had 1,566 deaths in 1900–1, but the number of cases is not recorded. In Italy in the four years 1901–4 there were 60,532 cases of small-pox, with 14,951 deaths, or 24.7 per cent. These three countries, Spain, France, and Italy, with their extensive Mediterranean seaboard, are constantly under risk of infection from North Africa, where small-pox is very prevalent. There is every probability that the London small-pox of 1901–2 had the origin indicated by these facts, and the type of disease supports that view.

American Type.

In searching for a source of the much modified small-pox which prevailed in the provinces in the same period,

we have to look to the New World. In Trinidad in 1902–3 mild small-pox was imported from Venezuela, and in 5,256 reported cases there were only 28 deaths, or 0.53 per cent. For a time there was much difference of opinion as to the nature of this disease, but it appears ultimately to have been accepted as variolous.[4] In the United States small-pox of a very mild type has prevailed for many years. Returns are incomplete, as some States do not furnish reports, but the following comprise the records for the years with which we are dealing at the moment:

Year.	Cases.	Deaths.	Percentage.
1901	48,206	1,085	2.3
1902	55,857	2,111	3.7
1903	40,581	1,382	3.4

How this American type may have reached this country is illustrated in the following note addressed to the LANCET and BRITISH MEDICAL JOURNAL in 1901 by Dr. Boobbyer on an outbreak of small-pox at Mormon head quarters in Nottingham.

> Small-pox has recently been introduced into the Mormon head quarters in this city, apparently by letters or other fomites from Salt Lake City. The first of our cases appears to have had a very mild attack and slight rash about February 1st; the second, also a very slight one, had a rash commencing about February 21st. The third and fourth were somewhat more severe than the preceding, but still very slight, and their rashes dated from about March 24th. The fifth, another extremely mild case, began to develop a rash on April 14th, at which date I first became aware of these facts, and at which also the entire household were removed to our isolation hospital. . . . I regret to say that the outbreak has been the means of communicating small-pox to Leicester, Loughborough, Derby, Sheffield, Liverpool, and probably some other places, though in single cases only, I believe, in each instance up to the present. The special cause of this latter general dissemination was in a small Mormon conference held in Nottingham on March 24th, at which date the rashes of the third and fourth local cases were developing.

The first case among the Mormon missionaries occurred about twelve days after receipt by them of a parcel from

Salt Lake City. Mormon activities, it may be mentioned, are asserted also to have been responsible for New Zealand small-pox in 1913–14, a Mormon missionary being the reputed agent.

In 1901 Dr. Meredith Young had a very mild case in Stockport, infected from raw cotton exported from Texas, and, in reply to inquiry, the State medical officer explained that small-pox was quite prevalent, but so mild as to need no medical attention nor cessation of work.

In the United States this much modified small-pox has continued, and the fatality rates are even lower than those of 1901–3. In fact, from 1906 to 1915 (the latest year of Dr. Bruce Low's statistics), the rate has not in any year reached 1 per cent. of the cases, so that the Trinidad experience has been repeated. In the States the disease in this form is now looked on as endemic, occurring here and there like scarlet fever, and comparatively little heed is given to it.

In Canada also benign small-pox has been the type in recent years. In Ontario, in 1912–15, in 2,446 cases there were 11 deaths, or 0.45 per cent.—that is, only one death in 222 cases.[5]

New South Wales has shared in the mild American type of the disease. In 1913–14 there were 1,661 cases, with only two deaths. Infection is supposed to have been imported from Vancouver, where the same type prevailed.[6] Recent facts relating to small-pox in this country still show a mild type of disease.

Intercurrent Severity.

Intercurrently with this modified small-pox there have been in the United States local outbreaks of high severity. Pittsburg in 1912 had 33 deaths, or 27.3 per cent., in 121 cases, and other local rates of 25.6, 25.0, and 28.6 are mentioned. New York City in 1901–2 had 3,480 cases with 720 deaths, or 20.7 per cent. Similarly Ontario had, a few years before the low fatality rates above mentioned, a very different kind of small-pox. Dr. Hodgetts, secretary

to the Provincial Board of Health, writing on mild small-pox (Toronto, 1905), gave the following figures for certain outbreaks in different parts of the province :

Year.	Cases.	Deaths.	Percentage.
1884	202	67	33 0
1885	146	16	10.9
1889	49	13	26.5
1899	30	9	30.0

In our own country in 1899–1900, just before the mild epidemic began, the city of Hull had a considerable epidemic of a severe type. The total cases were 943, and the deaths 163, or 17.3 per cent. With regard to possible origin, the medical officer writes in his report for 1899 :

> The great emigrant traffic through this city and port, especially from Southern Russia, may, in spite of the vigilance of the authority, have contributed a source of infection, for among the emigrants, persons had been frequently recognized as having recently had small-pox, and possibly the means of their disinfection had not been altogether efficient.

In 1903–4 Hull had a share in the then prevailing epidemic, and the type of the disease was that occurring generally throughout the provinces. The cases were 184, and the deaths 10, or 5.4 per cent.

Glasgow had a somewhat similar experience. An epidemic began there in April, 1900. The first case was that of a seaman on a vessel which arrived in Glasgow on March 18th from Bombay. The disease was confluent small-pox, and on discovery the symptoms indicated that his attack was well advanced towards the end of the second week. The effects of this source of infection did not extend beyond August, 1902. The fatality of the disease originating thus in 1901–2 was comparatively high —12.5 per cent. For more than a year from August, 1902, there was practically no indigenous small-pox in Glasgow. In September, 1903, however, a fresh epidemic began, the disease being introduced by navvies from the Talla Waterworks in Peeblesshire, and the fatality rate for 1903–4 was 7.6 per cent.

Bristol in 1908 had an introduction of small-pox of a severe type, from the Sea of Azov in Eastern Europe; the cases numbered 61, with 12 deaths. Again in 1915 a case introduced from Spain to the port of Bristol gave rise to an exceptionally severe outbreak of 32 cases, with 7 deaths. (Spain, as noted above, is apt to be infected from North Africa.)

Dr. Franklin Parsons [7] relates that:

> In one town in Lancashire there were outbreaks from two sources concurrently; one could be traced to the cases imported from America, of a mild type, while another was traceable to the infection which had come across from Paris via London, and that was severe.

Mainly, however, small-pox in this country has been attenuated in type in quite recent years. Cardiff in 1916 had 51 cases with 3 deaths. In March and April, 1918, an outbreak amounting to 33 cases occurred in the East of London. Air raid shelters played a part in the spread of infection. The medical officer of the Local Government Board reports that "the type of the disease in this outbreak was very mild and no patient died except the presumed first one." Much vaccination and revaccination resulted in the locality.

The remarkable change in the type of small-pox from severe to mild, as recorded above, has occurred on the whole somewhat suddenly. It is true that the Metropolitan Asylums Board figures already quoted show some diminution between 1871–2 and 1884–5, but the drop from 15.9 in 1884–5 to 8.0 in 1892–3 is the first really striking change, and, except in London, there is a further appreciable fall in 1902–5.

Improved hospital accommodation and medical treatment and nursing and diagnosis cannot account for the change in this country, still less for the Trinidad, American, Canadian, and New South Wales experiences.

It is common knowledge that when small-pox is absent vaccination diminishes, and the occurrence of extraordinarily low fatality rates during and after a period

of years in which vaccination has been less practised testifies further to the mildness of type of the existing disease.

Relation of Types.

The question naturally occurs whether these two different types of small-pox—the African and the American—are really the same disease or whether they have some relation to each other more or less analogous to that which exists between typhoid and paratyphoid. It is safe to say that vaccination supplies the answer. So far as I have seen, the great bulk of the evidence is to the effect that vaccination prevents the mild type just as it prevents the severe type. The relationship of vaccinia to the two types appears to be identical, and Jenner's conviction, which originally was much disputed, that variola and vaccinia are essentially the same disease, is now almost universally accepted. Evidence similar to that of the preventive power of vaccination against the mild and the severe infections has its parallel in evidence that the one infection prevents the other—the severe preventing the mild and vice versa. The conclusion, therefore, is that both infections are variolous. As Chapin said when mild small-pox was spreading in America:

> The crucial test of the identity of the two forms is, however, to be found in their immunity relation. Persons who have had small-pox or who have been successfully vaccinated are at least as immune to the mild as to the severe type. It is also found that persons who have had the mild type are equally immune to vaccination.[8]

When the mild disease first showed itself prominently it was naturally regarded as a "sport" of small-pox, the sport being the exceptional form. If, however, it should now gradually displace throughout the civilized world the severe form, then by and by the severe form would have to be regarded as the sport and the mild form as the normal—but that is a speculation which would carry us far into the future.

What are the conditions which cause small-pox to assume high virulence in one part of the world at one

time and attenuation in another part of the world at another time, is a question of much epidemiological and practical interest, and is well worthy of study, say, by the Medical Research Committee. Comparison could be made of the conditions in Africa on the one hand, and in Venezuela and Trinidad on the other hand. Quite probably, high aggregation of cases in houses, or hospitals or towns, or such overcrowding and misery as existed in Paris at the time of the siege in 1870, may have favoured development of virulent or septic types, while opposite conditions may have the opposite tendency.

Fatality of Natural Small-pox.

The statistics which I have given include vaccinated and unvaccinated, so that the gross figures for individual towns with differing amounts of vaccination, if compared with each other, are somewhat fallacious. Taken broadly, however, and looking to the very considerable number of places included in the tables. they do not, I think, contain any important error, when applied to the country as a whole, in showing the fatality rates at successive periods. It is obvious, too, that the remarkably attenuated or American type of small-pox, which has so extensively replaced the severe or African type in recent years, is a reality, independent of statistics. And these lectures are addressed to a medical audience, which does not require to be convinced of the protective value of vaccination.

All the same, the epidemiological question of the fatality rate of natural small-pox at one period and another is of much interest. There being no vaccination in the eighteenth century, fatality rates, so far as they exist, relate to natural small-pox only.* Unfortunately, reliable data for that century are scanty, as the great majority of records are of deaths and not of cases. For the rest, it is necessary to eliminate the influence of vaccination since its introduction at the beginning of the nineteenth century, and to take note only of the fatality rates in the

* There was no statistical confusion, so far as I have read, between natural and inoculated small-pox.

unvaccinated. But the age incidence of small-pox has an important influence on the fatality rate in any given epidemic. It is a very fatal disease in infancy, the fatality diminishes rapidly to a minimum in the third quinquennium of life—the age period 10 to 15 years being the most resistant to death by variola—then the rate increases during the remainder of life. The fatality rate, therefore, of natural small-pox, assuming the type of the disease to be fairly constant, would yet vary with the interval between epidemics. If the intervals were only about five years the rate would be high, because the cases would be mainly those of children under 5. If, on the other hand, an epidemic took place after an interval of, say, fifteen or twenty years, the fatality rate would be lowered by the fact that many of the cases would be at the most resistant period of life.

Notwithstanding these difficulties, it does seem worth while to utilize such data as exist in endeavouring to discover what has been the course of natural small-pox in respect of fatality.

The Eighteenth Century.

When small-pox inoculation first came into vogue about the year 1720, various statistics were published to show the difference between the fatality rate of natural small-pox and of inoculated small-pox. The principal authority was Dr. Jurin, secretary to the Royal Society, and the general statements made are to the effect that the rate of natural small-pox was about 16 or 17 per cent. By 1726 Jurin had recorded 17,151 cases with 2,348 deaths, or 16.6 per cent. Others were added afterwards. I suspect the validity of Jurin's figures because of his curious assumption that all deaths under two years of age are to be put under such headings as overlaid, chrysoms and infants, convulsions, etc., but not small-pox, so that the cause of death is really unstated. We know that small-pox in pre-vaccination times was largely a disease of children, and that early childhood is a time of high fatality. With that reservation, and the further reservation

as to the possibility of some chicken-pox being regarded as small-pox, there is little choice but to accept for what it is worth Jurin's figure of 16 or 17 per cent. as the fatality rate of the period between 1720 and 1730, to which the data refer.

The next available figures relate to the London Hospital for Small-pox and for Inoculation, and it is recorded that in the period 1746 to 1763 there were 6,456 cases and 1,634 deaths, a fatality rate of 25.3 per cent. In the last quarter of the eighteenth century—say 1775–99—it is stated that the rate in that institution was 32.5 per cent. It will be noted, therefore, that the rate was increasing three-quarters of a century before vaccination began.

The Nineteenth Century.

In 1836 to 1851, 2,654 unvaccinated cases in the same hospital had 996 deaths, or 37.5 per cent. In the epidemic year 1833, there were 387 unvaccinated cases with 155 deaths, or 40.1 per cent.* But Marson, who gives these figures, points out that these rates were somewhat higher than natural small-pox ought to yield, because severer cases were often sent to the hospital, and it was sometimes overcrowded.

1870–73.—The next figures are more certain, and relate to the epidemic of 1870–73. Dr. Seaton, in his report on that epidemic to the Local Government Board published in 1875, gives the fatality rate in the hospitals of the Metropolitan Asylums Board as 44.8 per cent.—say 45 per cent. This rate, like those already mentioned, is based on so large a number of cases as to make it fairly reliable, and it appears to indicate the maximum virulence in respect of epidemic fatality to which small-pox has reached in this country during the past 200 years. This view of the extraordinary virulence of the small-pox of 1870-73 does not depend merely on statistics. Dr. Munk and Mr. Marson, the medical officers to the Small-pox and Vaccination Hospital (which was still in use at this time after

* Gregory (loc. cit.) gives 396 cases with 157 deaths in 1838.

the institutions of the Metropolitan Asylums Board had been opened) refer to

> the severity of the disease, and especially to the number of cases of malignant small-pox, the proportion of which to other cases has been very largely in excess of anything within the previous experience of either of your medical officers.[9]

Dr. Seaton writes:

> The ratio in the hospitals of provincial and foreign towns generally has ranged from 40 to 50 per cent. among the unvaccinated, and from 8 to 10 or 11 per cent. among the vaccinated —enormous rates, and attributed everywhere to the same cause, viz.: the unusual proportion of malignant, black, and haemorrhagic cases. . . .

In hospitals at Berlin "the mortality among the unvaccinated was 81.25 per cent. and among the vaccinated 14 per cent." In the hospital at Leipzig "the mortality among the unvaccinated was 71 per cent., and among the vaccinated (including doubtful cases) between 9 and 10 per cent."

The years 1873–84 in the metropolitan hospitals show a rather lower rate of 38.6 per cent., based on 2,169 cases and 838 deaths. (Gayton.)

1892–95.—Disregarding smaller or localized outbreaks, and turning to the next extensive epidemic in this country, that of the early nineties, the Royal Commission states that in London in 1892-93, among 409 unvaccinated cases there were 99 deaths, or 24.2 per cent. If "doubtful" cases are included the number is increased to 580, with 127 deaths, or 21.9 per cent. For the provinces I have taken out the figures for a large number of populous places with considerable prevalence of the disease in 1892-95, and find that in 2,550 unvaccinated cases there were 662 deaths, or 26.0 per cent. In various outbreaks the reports distinguish between the doubtful and the unvaccinated. The figure just given includes the doubtful. Of these there were 261 cases, with 42 deaths. If they be deducted the particulars are 2,289 cases, with 620 deaths, or 27.1 per cent. (See Table III, page 18).

1902–5.—Coming now to the latest epidemic of any extent—1902–5—I find that in 1,305 unvaccinated cases in the provinces there were 247 deaths, or 18.9 per cent., and that if doubtfuls are deducted the cases are reduced to 1,088 with 198 deaths, or 18.2 per cent. (See Table IV, page 19). In the Metropolitan Asylums Board's hospitals in 1901–2 the Continental or African type of small-pox caused a fatality rate of 33.1 per cent. in the unvaccinated —2,278 cases, and 753 deaths.

TABLE III.

Provincial Small-pox Fatality Rates in the Unvaccinated.
(*Including Doubtful Cases.*)

Epidemic 1892–95. All ages.

Place.	Time.	Cases.	Deaths.
Dewsbury	1891–2	390	94
Warrington	1892–3	68	24
Leicester	1892–3	158	19
Liverpool	1892	24	9
Birmingham	1893–4	437	127
Aston Manor	1893	15	5
Brighouse	1892–3	36	11
Manchester	1892–4	155	34
Salford	1892–3	35	12
Halifax	1892–3	88	36
Leeds	1893	88	17
St. Albans	1893	10	4
Keighley	1893	41	6
Bradford	1893	229	64
Walsall	1893–4	239	70
Nottingham	1893	12	4
Hinckley	1894	19	3
Willenhall	1894	89	30
Bristol	1893–4	41	11
Oldham	1894	48	14
Derby	1895	27	8
Dublin	1894–5	201	60
		2,550	662 = 26.0%
Deduct doubtfuls...	—	261	42
	—	2,289	620 = 27.1%

With regard to all these rates the reservations that require to be made have already been indicated. I would be glad to see a fuller collection and closer analysis of all available data, which quite likely would make some alteration in details, but the figures at least give some support to the thesis just indicated, namely, that beginning with the year 1720, in the absence of comparable data for

any preceding period, natural small-pox gradually became throughout the eighteenth century, and up to the epidemic of 1870–73, a more virulent and fatal disease,* its maximum fatality being on a large basis of facts 45 per cent., and since then it has irregularly, yet persistently, diminished in fatality until we come to the epidemic of 1902–5 with its unvaccinated rate of 19.3 per cent.

TABLE IV.

Provincial Small-pox Fatality Rates in the Unvaccinated.
(Including Doubtful Cases.)

Epidemic 1902–5. All ages.

Place.	Time.	Cases.	Deaths.
Ossett Union	1902	133	37
Eccles	1902–3	3	2
Leeds	1902–5	185	18
Nottingham	1902–3	24	3
Newcastle	1903–5	138	14 (or 1902 ?)
Stockport	1902–4	40	6
Bradford	1900–1	8	0
St. Helens	1903	4	0
County Palatine of Lancaster	1904	125	11
Cardiff	1901 and 1903	14	1
Swansea...	1902	16	7
Halifax	1903–4	40	5
Wigan	1902–3	12	1
Salford	1903	31	3
Oldham	1902–3	140	11
Tynemouth	1902–3	44	2
Felling-on-Tyne ...	1903–4	41	8
Glasgow...	1900–1	168	88
,, ...	1903–4	155	37
Dublin	1903–4	67	21
		1,388	275 = 19.8%
Deduct doubtfuls...	—	217	49
		1,171	226 = 19.3%

Since 1902–5 the disease has been so little prevalent as to furnish no sufficient material for a further statement of reliable fatality rates, but such figures as exist, broadly looked at, continue to point in the same direction. Indeed, if the American type of disease be regarded as having replaced the small-pox of former days, the pestilence has been reduced to a mere shadow of its old self in respect

*I argued similarly in *Vaccination Vindicated* in 1887, and pointed out that Dr. Munk had advanced the same view in 1881.

of its ability to kill those whom it attacks. We must never forget, however, that intercurrently the African type of the disease appears every now and then, even in areas where the attenuated strain is so well established as to be considered endemic; and we dare not prophesy, but can only hope that the mild may ultimately displace the more virulent form of variola.

(*b*) Infectivity.

Two factors go to make up the inherent capacity of a case of small-pox to convey infection to persons within the range of its influence. One is the character of the infecting organism which, reasoning by analogy, is assumed to be the *causa causans* of the disease. The other is the amount of the *materies morbi* in a given case. In a word, the two factors are quality and quantity.

Quality.—Unfortunately, bacteriology has not yet conclusively identified the organism. In this respect small-pox resembles measles, whooping-cough, and typhus, but differs from diphtheria, enteric fever, and tuberculosis. By observation, however, we know that those infections whose organism is undiscovered differ from each other in the certainty of their infecting power. I do not myself recollect ever seeing a sporadic case of measles. A single case means an outbreak. Whooping-cough is not so readily kept under observation by the health officer, but my impression is that it must be almost as certainly infectious as measles. In respect of scarlet fever the position is very different. It often occurs sporadically, and a single case does not necessarily portend an epidemic. Either the disease may die out, or dropping cases may continue to occur for weeks or months before there is any epidemic. In diphtheria, whose organism has been studied, Dr. Davies of Bristol found that a marked increase of infectivity, under which sporadic cases were supplanted by epidemic prevalence, was accompanied by a definite change in the characters of the organism.[10]

Small-pox has more resemblance to scarlet fever than to

measles in respect of the possibility of sporadic cases. In Kilmarnock in the eighteenth century (where it should be observed, however, that only deaths and not cases are recorded) there were, in inter-epidemic periods, occasional deaths which formed no part of an outbreak. In well-defined epidemics occurring every four or five years in a town with a probable population of over 4,000 the deaths ranged from 45 to 84, but between some of the epidemics there was an occasional sporadic death, and in one year a straggling prevalence over seven months yielded 8 deaths without attaining the dimensions of an epidemic. In Glasgow I have heard of a man with a fully developed and abundant eruption being discovered seated in a place of public resort (George Square), and it was found that for about a week he had been freely exposing himself whilst in this condition. Yet not a single case of small-pox resulted from this missed case. That was a most exceptional occurrence, but seems to show an absence of infective quality in that particular case.* Such occurrences are more likely during the decline than during the rise of an epidemic. After the pre-epidemic period referred to in the next paragraph has passed, the small-pox of a rising epidemic seems more infectious, and with more carrying power, than that of an epidemic which has passed its meridian. Commonly, but by no means invariably, rise and decline are associated with respective periods of the year, prevalence rising from about December to May and falling from about June to October.

Small-pox epidemics sometimes begin very slowly, and sometimes break out very suddenly. In Kilmarnock in the eighteenth century there were instances of both sorts, but most of the outbreaks were pretty sudden. Deaths, not cases, of course are the criterion in prevaccination times. Dr. Seaton in 1868 called attention to this feature of slow onset of epidemics which had occurred in Cardiff and Sheffield in 1857. He regarded it as characteristic of all small-pox epidemics.

* Dr. Killick Millard, in his Leicester report for 1902, mentions two or three cases o the sort.

In London in 1901 the epidemic spread was very slow. At the beginning of the year there was one case in hospital, and the following were the monthly admissions:

January...	2	July	14
February	1	August	82
March	0	September	167
April	0	October	272
May	1	November	438
June	5	December	761

Taking May as the onset, it was not till August that the dimensions of the outbreak became very noticeable.

The Gloucester epidemic of 1895–6 had a similar slow onset. Here are the figures:

Month of Outbreak.	Cases.	Month of Outbreak.	Cases.
1st	1	10th	604
2nd	—	11th	733
3rd	3	12th	283
4th	1	13th	122
5th	3	14th	13
6th	7	15th	—
7th	12	16th	—
8th	52	17th	—
9th	145		
		Total ...	1979

On the other hand, Edinburgh furnished an example of a small-pox outbreak which developed quickly. Owing to dispersion of navvies from Talla Waterworks (in the county of Peebles), where small-pox existed, four cases occurred in Edinburgh in December, 1903, and the monthly progress of the outbreak was as follows:

December, 1903 ...	4	June	10
January, 1904... ...	34	July	4
February	63	August...	nil
March	32	September	nil
April	14	October	1
May	10		

Quantity.—Leaving now what, after all, is mainly conjecture as to the quality of the contagium vivum of small-pox, I turn to the much clearer question of the influence of quantity. It is an accepted fact that the eruptive material of small-pox, both cutaneous and buccal, is the infective

agency, and there is no need to refer to the proof which inoculation affords of the truth of the proposition that small-pox vesicles and pustules and crusts are the *materies morbi* of the disease. So far, therefore, as quantity is concerned, the amount of the eruption, not merely on the skin, but also on the mouth and throat, in any given case is a measure of its inherent capacity for spreading infection, if opportunity be given by the infective material coming into due relationship to susceptible subjects. In the vaccinated, however, an originally copious eruption sometimes aborts remarkably, with corresponding effect on the amount of infective material.

It is not necessary to search through detailed reports of hospitals and of health officers to demonstrate that there has been in recent years a great diminution in the total average amount of eruption per case of natural small-pox. Broadly speaking, eruption and fatality rate go hand in hand. Confluent, discrete, and sparse eruption are accompanied by characteristic differences in case mortality, and this is so obvious that the proposition need not be laboured. It has been shown above that the fatality of small-pox is greatly reduced in recent years. Therefore the amount of eruption must have been greatly reduced, and in the same proportion the amount of infective material has been lessened. Small-pox, therefore, has been and is a much less infectious disease than it was half a century ago.

(*c*) Prevalence.

Fatality being reduced, and infectivity being reduced, it follows that, other things being equal, prevalence must also have diminished, and Dr. Bruce Low's report gives abundant evidence that this is the case.

In England and Wales the deaths have remarkably diminished. In five successive decades they have been:

1867–76	58,614
1877–86	18,026
1887–96	4,892
1897–1906	4,763
1907–16	139

The total notified cases in the years 1911–17 have been only:

	1911.	1912.	1913.	1914.	1915.	1916.	1917.
Totals notified	295	123	115	65	90	149	5
Of which in port towns ...	20	72	48	10	31	55	2
In port sanitary districts...	30	12	25	7	12	14	1

These are very striking figures, showing that in the seven years small-pox has obtained almost no hold in the country, even when repeatedly introduced at seaports. In London the notifications since 1905 (after the epidemic had terminated) have only been in successive years to 1916 inclusive, 74, 31, 8, 4, 21, 7, 72, 6, 4, 21, 3, and 1. In Liverpool from 1904 to 1916 inclusive there have been only 144 cases with 4 deaths, and the last three years of this period have had only two cases, neither fatal. In Edinburgh and Glasgow in the five years 1912–16 inclusive there has not been a single notification, and in the twelve years 1905–16 the total cases in the two cities have been 37, with one death. In Ireland in the twelve years 1906–17 there has been one death.

On the Continent the Scandinavian countries have shared in Britain's remarkable freedom from small-pox, and so also has Holland. Sweden had only 18 deaths in the twenty-two years 1895–1916. Norway in the sixteen years 1899–1914 had 376 cases with 27 deaths, or 7.2 per cent. Denmark had 18 deaths in the twenty-five years 1892–1916. Its cases were about 300, so that the fatality rate was about 6 per cent. Holland had 124 deaths in the twenty years 1897–1916. The number of cases is not stated. Belgium has had much small-pox, but it has greatly diminished since an epidemic early in the present century, culminating in 1903, in which year there were 1,630 deaths in cases estimated at 10,000, which gives a fatality rate of over 16 per cent.—very similar to the rates in Paris and London in the same epidemic.

In France there has been no such complete disappearance of small-pox, though the deaths in the six years

1903–13 (the latest available data) were only 939. For Paris the figures are known up to 1916 inclusive, and in the four years 1913–16 the cases were 103 and the deaths five. In the Paris epidemic of 1900–1 it has already been noted that the fatality rate was the same as London's, 16.8 per cent. In subsequent years it has been much less, the cases having been 4,773 and the deaths 399, or 8.4 per cent. In Marseilles there has been very considerable prevalence, and in 1906–7 the fatality rate appears to have been very high, but there have been few cases from 1908 to 1915.

In Spain there has been much small-pox, but details are vitiated by small-pox and chicken-pox being classified together. Portugal also has had much small-pox. In Switzerland prevalence has diminished since 1905, though the fatality rate has been 13 per cent., the cases having been 345 and the deaths 45. In 1900–1 there were 567 cases and 67 deaths, or 11.8 per cent.

In Italy the disease has been very prevalent and the fatality high. In the twenty-nine years 1888–1916 there were 320,161 cases and 81,289 deaths, or 25.3 per cent. In the last three years of this period, however (these being war years as it happens), prevalence was much less and the fatality rate low—2,126 cases and 57 deaths, or 2.6 per cent.

Small-pox in Germany will be considered in the next lecture.

In Austria up till 1900 there was heavy prevalence with fatality rates of 20 to 40 per cent. From 1901 to 1914 inclusive the disease was at a low ebb, with fatality rates much below the previous level, but in 1915 and 1916 there have been nearly 50,000 cases, though the deaths are not stated.

Hungary, like Austria, had much small-pox, but there has been very regular diminution from 15,470 deaths in 1887 to 81 deaths in 1912, the last year for which figures were obtained. It is probable that the disease has had some prevalence during the war, though Budapest is the only town of which that can be said with certainty.

In Russia there is a great deal of small-pox, with apparently a very high fatality rate, though there is probably some fallacy owing to incomplete returns of cases.

The above facts as to the continent of Europe, taken from Dr. Bruce Low's report, show that while in some of the countries there has been much less small-pox in recent years, in others there is still a high prevalence, and the constant intercourse between the United Kingdom and the Continent maintains a degree of risk which prevents any sense of security against successful invasion by the disease. Also, there is always a minor risk of small-pox by cotton from America, and by paper or other textile fabrics, as exemplified in Dr. Macewen's reports to the Local Government Board on outbreaks in cotton mills in Lancashire.

But, reverting to our own country, during the last half-century there has been, with the exception of the metropolitan epidemic of 1901–2, a great diminution in the fatality and the infectivity and the prevalence of small-pox. This diminution has progressed at an increasing rate of speed. In the latter part of the half-century, and in particular since the mild epidemic of 1902–5, the country has shown unparalleled freedom from the disease, not merely in respect of fatality, but also in respect of prevalence.

REFERENCES.

[1] A Letter to Dr. Freind showing the Danger and Uncertainty of Inoculating the Small-pox, 1722. [2] Tweedie's *Practical Medicine*, Lond., 1840, i, 291. [3] *Public Health Administration in Glasgow*, p. 92 (Maclehose, Glasgow, 1905). [4] Seheult, *Proc. Roy. Soc. Med.*, Lond., 1908, i (Epid.), p. 229. [5] Dr. Bruce Low's Report, p. 100. [6] Armstrong, *Proc. Roy. Soc. Med.*, Lond., 1914, viii (Epid.), p. 2. [7] *Proc. Roy. Soc. Med.*, Lond., 1912, v (Epid.), p. 43. [8] As quoted by Armstrong (loc. cit.). [9] Report of the Medical Officer of the Local Government Board, 1874, 53. [10] *Public Health*, Lond., xix, 349.

Lecture II.

VACCINATION AS IT WAS AND IS.

The Law.

Neither infantile nor re-vaccination has ever been compulsory on the population of the United Kingdom. The utmost penalty has been the infliction of fines, and non-payment of a fine has sometimes involved imprisonment, but the law has never allowed a child to be taken out of its mother's arms and forcibly vaccinated.

Various changes have taken place in law, practice, and doctrine since 1870. Vaccination was made obligatory in England in 1853. Boards of guardians were empowered to appoint vaccination officers in 1867; appointment of these officers was made compulsory in 1871. In 1898 domiciliary vaccination was to a great extent substituted for vaccination at public stations, and systematic asepticism in the operation was insisted on and arranged for. At the same time exemption on the ground of conscientious objection was enacted. The procedure for obtaining exemption was made easier in 1907. Public vaccinators and vaccination officers are under the Poor Law authorities, not under the health authorities, as obviously they ought to be. The age for obligatory vaccination has been raised from three months to six months, as in Scotland.

In Scotland the obligatory law was passed in 1863, but the duties of public vaccinators were and are confined to defaulters who have omitted to secure the vaccination of their offspring before the age of 6 months. For the rest, vaccination is the concern of the private medical attendant and the child's parents, excepting for certain public vaccination stations where medical students are educated. Exemption since 1907 is obtainable even more easily than under the English Act.

Revaccination is entirely voluntary in both countries.

Decline in Practice.

Systematic practice of infantile vaccination has greatly diminished in recent years. At the same time that small-pox has become a much less prevalent and much less fatal disease than before, exemption from vaccination has been made very easily obtainable, and the Jennerian prophylaxis has largely fallen into disuse. The English Local Government Board's annual tabulation of vaccination returns has been discontinued during the war, so that the most recent statistics relate to the year 1912. At that time about one-half of the infants born and more than one-half of those surviving to the vaccination age were being vaccinated. No doubt vaccinations, in the absence of small-pox and under the easy system of exemption, have considerably diminished since then.

In Scotland in 1916 (the latest year for which figures are available) amongst the children surviving at six months —the statutory age for infantile vaccination—the percentage of unvaccinated was 41. This is a little less than the percentages for the two previous years, but much higher than the rate—6 per cent.—of the years before the Act of 1907, which facilitated the obtaining of exemption certificates.

The Doctrine.

The doctrine of vaccination has mainly altered in respect of, first, the need for revaccination, and, secondly, the value of recent vaccination when small-pox tends to become prevalent. Jenner's one serious error—that vaccination gave lifelong protection—resulted in this country being behind Germany in realizing the need for revaccination. But Marson,[1] giving his experiences of the London Small-pox Hospital, says, "I have always recommended revaccination after puberty," especially for persons indifferently or doubtfully vaccinated in infancy, or without any cicatrix remaining. Dr. Seaton declared in 1874:[2] "the revaccination of persons as they reach about fifteen years of age should be as systematically done as is the vaccination of young infants," and he states that he

laid down this rule some years previously. Opinion regarding the proper period of life for systematic revaccination has tended to change in the direction of an earlier repetition of the operation, adolescence in the original view having now been replaced by the age of 9 or 10 years, especially in presence of small-pox. Also, although it is generally recognized that, because it is done at an age when the process of bodily growth and development has been largely accomplished, revaccination efficiently performed yields a more prolonged protection than primary vaccination, yet when there is appreciable risk of small-pox infection the operation should again be repeated, especially if many years have passed. In the Local Government Board's Report for 1887 it is stated that "whether the protective influence of this second vaccination becomes impaired, and if so, under what conditions, is not known."

Germany.

This development of view as to the desirability under such circumstances of renewed revaccination will probably be strengthened when we become more acquainted with the facts as to small-pox in Germany during the war. It has always been known that under obligatory revaccination in that country such trivial amount of small-pox as occasionally did occur was to be found mainly on the frontiers, where Germany adjoins very incompletely vaccinated countries like Russia. Two or three million Russian prisoners interned in various parts of Germany have permeated that land to an unparalleled degree, and the risks of infection, which were formerly almost confined to the borders, have accordingly been extended right into the heart of the country. In 1917 in Berlin about 4,000 cases of small-pox occurred, with over 400 deaths. The strong vaccinal defences of modern Germany have, in short, been subject to more strenuous attack than ever before, and the protection which had been sufficient against occasional trivial invasions has been less able to resist the more prolonged and heavier onslaught. A German whose personal immunity had not been absolute

was further protected by the generally high standard of immunity of the population, so that his chances of direct infection were few and rare. At the same time, it is reasonable to think that the privations of Germany in respect of the ordinary necessaries of life—food and clothing and heating—taken together with the domestic and public anxieties of the war owing to deaths and disablements, have made the population to some degree more vulnerable to infectious disease. In Germany it should be noted that the male population fit for military service has, broadly speaking, the protection of a second revaccination on entering the army, while females and all males who for one reason or another were not drafted into the army have had only a single revaccination. It will probably be found that mainly in this section of the population has small-pox reasserted itself during the war.

In Germany, or at least in its civil population, forcible vaccination or revaccination has not been the law.[3] The highest penalty is by fine or by imprisonment not exceeding three days, and, as ought to be the case in this country, vaccination and revaccination are on the same legislative footing. The German population, however, has been so drilled in ways of obedience that defiance of the law has been comparatively rare.

Calf Lymph.

In the practice of vaccination a most important change has taken place through the substitution of calf lymph for humanized lymph. The change resulted mainly from a desire to allay parental anxiety regarding the possibilities of conveyance of human disease by means of humanized lymph. This anxiety hardly existed in the medical profession, who freely vaccinated their own children from the arms of infants, the risk being so remote as to be considered practically negligible. The great virtue of calf lymph under present conditions is the facility with which, notwithstanding the time required for glycerination or other treatment, the supply can be multiplied at relatively short notice to meet the most extensive epidemic. It has

been provided by the Local Government Board to all public vaccinators since the beginning of 1899. In 1870–73 and up to the period when calf lymph came into general use, it was extraordinarily difficult to obtain material sufficient for emergency revaccination called for owing to the existence of small-pox. Everything depended on the number of infants presented weekly for vaccination, and they might very readily be utterly insufficient for the purpose. This was so in Kilmarnock in 1873. In these circumstances many persons requiring and desiring to be vaccinated might remain unprotected, and there would even be temptation to resort to lymph taken from the vesicles of revaccination, a source which has never been regarded as satisfactory. In addition to the facility with which the supply of calf lymph can be increased it is now regularly kept in cold storage to the extent of half a million tubes by the Local Government Board. In the act of vaccination aseptic precautions are used to a very much greater extent than half a century ago.

Dosage.

One difference between practice in England and in Scotland is that in the former country the Local Government Board's standard of four vesicles with a total area of not less than half an inch is much more generally observed than in Scotland, excepting at the few vaccination stations. Certain statistics submitted to the Royal Commission on Vaccination rather seemed to indicate that the duration of protection conferred by infantile vaccination in Scotland was less than in England, and the explanation is not far to seek.

As regards the duration of protection afforded by different doses—at one time a matter on which bacteriologists tended to be sceptical—it is worth noting that all modern work on other vaccines has shown the primary importance of fixing a dose of bacilli at a standard rate, and that differences in the bacterial dose of the "vaccine" are every day accepted without question as explaining the whole difference between protection by and complete failure of

inoculations. Marson's famous statistics of the London Small-pox Hospital, supported as they were by Russell's striking diagram of Glasgow Hospital results, are consistent with modern bacteriology.

Vaccinal Condition of Population.

Besides what remains of systematic vaccination the present position with regard to the practice is, broadly speaking, that infantile vaccination and revaccination are resorted to in presence of small-pox.

Diminution in the vaccination of infants results in there being now a larger proportion of young adults who have not the protection against severity which vaccination in infancy would undoubtedly have given them, and have not the partial protection against attack which, in those well vaccinated in infancy, undoubtedly is maintained to a substantial degree in younger adult life. On the other hand, it has to be remembered that, in some places at least, the occurrence or threatening of small-pox has led to an amount of revaccination at different ages which in the mass is probably considerable, and that demobilization of the forces will add materially to the proportion of persons who have received protection in adult life. On the whole, however, one must regard the population as distinctly less protected than twenty years ago. Even at that time infantile vaccination was not, in the absence of revaccination, in any way a shield such as in normal times completely protected Germany. But it did interpose a very substantial—and in former years an indispensable—check on the spread of small-pox. If from this year onwards no vaccination whatever were done in this country, we should for many years have the benefit of protection hitherto obtained.

Infantile Vaccination and the Spread of Small-pox.

But in respect of infantile vaccination it is necessary to take notice of a contention which has been advanced as to the relationship of the practice to the spread of small-pox.

The view in question was promulgated in 1893 by Dr. J. H. C. Dalton of Cambridge and has been adopted and developed by Dr. Killick Millard, Medical Officer of Health of Leicester,[4] with all his characteristic energy and ability. The subtitle of Dr. Millard's book is "An Appeal for Reconsideration," and no one can have a better claim than he to make such an appeal. He has absolute faith in the protective power of recent vaccination against small-pox in the individual and has demonstrated his faith unequivocally in his work at Leicester. He took his own vaccinated children into the small-pox hospital, and had them photographed beside cases of the disease, using the photographs afterwards for persuasion of contacts to accept vaccination.

Briefly, he urges that to the public at large infantile vaccination is on balance disadvantageous because it often makes subsequent small-pox so mild as to be unrecognizable, with consequent spread of infection by missed cases. Therefore, he holds, the present law of so-called compulsory vaccination should be repealed. A subordinate reason submitted for this proposal is that repeal would diminish the opposition with which the offer of emergency vaccination in presence of small-pox is often met. That consideration is sound for what it is worth, but its value must be a matter of individual opinion, and need not be discussed here.

On the main contention, however, I desire to offer some observations. Though the Vaccination Acts are called compulsory they are so only in name, especially in recent years, and Dr. Millard agrees on that point. But legislation is a political question, and if infantile vaccination is a public danger there is no logic in confining its discouragement to the omission of legislative pressure. The discouragement should be active and definite. This would mean advice to a parent to refrain from vaccinating his child, the adviser hoping that if unfortunately the child subsequently took small-pox it should have so severe an attack as to make the disease easily recognizable, with a

view to its immediate isolation and the protection of the public. A considerable proportion of such attacks would of course be fatal. The proposition raises a question in medical ethics. It would surely be wrong to refrain from protecting one individual against severe or fatal small-pox in order that other individuals, adults or children, should escape the result of omission, by themselves or by their parents, to secure a safety which is open to all. But apart from ethics the view seems to me unsound that infantile vaccination is, on balance, disadvantageous in relation to the prevalence of and mortality from small-pox.

It may at once be agreed that infantile vaccination, by mitigating small-pox where it has failed to prevent it entirely, makes the disease much milder, with the result that on any large basis of fact more cases will be missed than if the attacks had been of ordinary severity. Indeed, modification as well as prevention of small-pox is one of the virtues of vaccination. But there is another side to the shield. It is true that an eruption of, say, ten pustules will more readily be overlooked than an eruption of 100 or 1,000 pustules. But the quantity of inherent infectivity is correspondingly less. Other things being equal, it is only one-tenth in the one case and one-hundredth in the other. The amount of buccal eruption, so far as it is important, corresponds broadly to the amount of cutaneous eruption. When a medical officer reports that certain cases of small-pox were so mild as to be unrecognized, he naturally thinks of this as increasing his difficulties, and is apt to forget the considerations on the other side. Severe small-pox is not by any means always recognized in its early stages, and a single "missed" case, say, in a vagrant, among a score or a hundred discovered cases may make all the difference in the spread of infection. Also, failure to notify small-pox has not always been due to non-recognition of the disease. In Dr. Spencer Low's report on the Dewsbury epidemic of 1904, he says that "non-notification of cases" in many instances meant "concealment of cases." It is clear that a mild concealed

case would be much less likely to spread infection than a severe, unvaccinated concealed case.

Experiences of Medical Officers.

The epidemic of 1892–95, and in the provinces the epidemic of 1902–5, have been so mild in character that, independently of vaccination, the difficulty of diagnosis has been naturally much greater than ever before. Consequently references to missed cases bulk largely in the reports of medical officers, and Dr. Millard is able to cite numerous instances. But easy diagnosis can be obtained at too great a cost, and a locality is much better with its mild cases, whether naturally or artificially mild, and its more difficult diagnosis, than it would be with severe cases easily diagnosed but with a high fatality rate and producing a large amount of infectious material, however carefully guarded. If a missed case is naturally mild it will tend to cause the disease in modified form; if it is artificially mild it will tend to revert to the natural type of epidemic. If that type itself be mild the difficulty of diagnosis will correspond. If, on the other hand, it be severe, then the desired facility of diagnosis will be obtained, but at the cost possibly of a heavy attack with disfigurement, or even death, as a frequent result.

Bristol.—Sometimes a mild case does cause a considerable spread of infection. Dr. Davies records that in Bristol, in January, 1912, an "ambulant" case set agoing a series of small outbreaks which extended over eight months —4 cases in January, 18 in February, 8 in March, 12 in April, 7 in May, 15 in June, 7 in July, and 4 in August. As no death from small-pox occurred in Bristol during 1912 the type of disease throughout must have been mild, independently of vaccination. In 1903, however, 15 introductions by sea and land were checked at 46 cases, and in his report for 1905 Dr. Davies records how one mild case wandered about with the eruption well out, visiting a public-house where there were many workmen. Great efforts were made, with the aid of the Local Government Board, to watch for secondary cases, but only one certain and one doubtful case occurred. The disease had been

since 1903 "of an extremely mild or minimal type which is possibly not highly infectious except to intimate, or bed-contacts," and which even in the unvaccinated may give merely a nominal attack. It appeared to have been imported from North America, and if the type remained unchanged, would be of as little importance as chicken-pox.

Derby and Halifax.—Dr. Howarth, in Derby, had in 1903–4 a total of 255 cases with 5 deaths, and states that the mildness of type resulted in a number of cases being overlooked, and in addition instances of delayed notification were frequent. He goes on to remark that such cases add to the difficulties of repressing an epidemic, "but I must confess to some surprise at the fewness of cases which resulted from these causes," and he suggests that dissemination of infection may be less easy because of the vesicles forming hard cornified bodies, "and in addition the amount of infective material available for dispersion is probably directly proportionate to the amount of rash" (p. 29 of Report). Dr. Neech of Halifax, writing regarding a discrete case in his report of 1903, notes that the first batch of cases infected from it occurred amongst persons in the same workshop and in the same lodging-house. "No case at this time occurred among the general public, although he was moving freely among them." *

Dundee.—There was considerable prevalence of small-pox in Scotland in the years 1900–4 inclusive, in large centres of population, especially in the industrial belt which lies across the Lowlands from south-west to north-east. Within this belt the city of Dundee is a manufacturing and port town, with at that time about 163,000 inhabitants, with a good deal of poverty and slum population, and with thousands of married women working in the great jute mills, and leaving their children at home.

In Dundee in 1902 there were 57 notified cases of small-pox, with 4 deaths. In the course of his report Dr. Templeman, the medical officer, writes as follows:

* Dr. Neech is of opinion that the disease is only slightly infectious until after the pustules have dried up and formed scabs.

In a considerable proportion of the cases the source of infection could not be traced. In a few it was ascertained that the person had been in contact with some one who was believed to have had a mild attack of chicken-pox, and in others to have suffered from influenza. I think there can be no doubt that during the whole course of the outbreak mild cases of small-pox were occurring which were not notified, either from the person not having sought medical advice, or from the case being diagnosed as influenza from the fact that no rash was discovered or as chicken-pox from the mild character of the symptoms.

The only unrecognized case from which a considerable number of persons were infected was that of a man, 49 years of age, who had been suffering from an eruption for two or three weeks, but, as his general symptoms were trifling, the eruption was regarded as that of a common skin disease. Several of his fellow-workers had been visiting him during his illness, and two of them suffered from well marked small-pox, as did also his daughter (married) and his cousin, who resided in the country. It was rather a curious fact that although nine other persons resided in the house along with this man, none of them seem to have contracted the disease, except perhaps a lodger, who had a very slight illness, which, however, did not incapacitate him for work, and who had a few papules amongst his hair. One of his fellow-workmen afterwards contracted small-pox, and was probably infected by him.

In 1903, 36 cases were notified in Dundee. Dr. Templeman writes:

In a considerable number of instances the source of infection could not be traced, though it was in several cases found that the patient had been in contact with supposed cases of influenza or chicken-pox, these having really been cases of modified small-pox.

Notwithstanding such mild and unrecognized cases of small-pox, the disease obtained no large hold in Dundee. Throughout the five years 1900–4 the number of notified cases was 175, with 12 deaths, or 6.9 per cent. The disease was therefore of a fairly mild type, and difficult to diagnose. But infantile vaccination had been well attended to. Deducting "insusceptibles" and deaths before the age for vaccination, the percentage of unvaccinated survivors at six months of age was only 4.7. Whether this town would have profited in respect either of deaths or attacks, if infantile vaccination had been successfully discouraged in order to make diagnosis easy, is a question which hardly seems to require an answer.

Sydney and Trinidad.—In the remarkably mild Sydney epidemic of 1913 Dr. Armstrong calls attention to the low intensity of infectivity, and records that—

> In the course of the epidemic twenty-seven country towns or districts of New South Wales were invaded by small-pox, and the total number of cases diagnosed in these localities only amounted to fifty-two. The greatest number of persons attacked in any one locality was six, and in sixteen localities only one person was attacked.

And of the Trinidad epidemic of 1903 Seheult says:

> The slow spread of the epidemic was due to the slight infectivity of the disease. In many cases the contagion or virus seemed to require intimate contact for its transmission from one person to another, and even then it was remarkable how frequently instances were found in which such contacts escaped infection. (*Proceedings Roy. Soc. Med.*, Lond., 1908, i (Epid.), 236.)

Dunbartonshire and Stirlingshire.—My own experience of the risks of infection from small-pox so mild as to be hardly recognizable is that it is not very infectious. A case which greatly impressed me was that of a woman whose attack was discovered only through her having infected two persons within her own dwelling. She had been moving about freely in the town where she lived, shopping and meeting people on the streets. I feared an outbreak, but after hesitation it was decided to delay advertising a general offer of emergency vaccination, and to maintain vigilant watch for cases. Outside the woman's own dwelling not a single case occurred.

In my annual report for 1905 to the County Council of Stirlingshire I wrote as follows regarding a small-pox patient, Mrs. R. B., aged 35, of Stenhousemuir, the wife of a Carron Company's workman:

> Her case is interesting with regard to the source of infection. The medical attendant informed me that, after the beginning of the year, the husband had had a slight illness, which was regarded as influenza, but that connected with it there had been one or two spots on the scalp. I interviewed the husband, and found that his illness had begun in Stenhousemuir, and had continued while he was temporarily employed in Bradford, and that he observed the spots on his scalp merely because they gave him trouble in combing his hair. I communicated with the medical officer of Bradford, and learned that he had been investigating an outbreak of small-pox which had occurred on

January 30th, which he suspected to be due to a Scotsman from Carron Company, who had taken lodgings on January 16th, and had felt poorly, and thought he was suffering from influenza, but had no medical attention. He returned from Bradford on the 23rd, and his wife sickened on February 7th, or fifteen days afterwards, so there is no doubt she got the disease from her husband. This case illustrated a frequent experience. The man's attack was exceptionally mild, and he infected no one outside the house in which he lived, though he was in contact with many people outside. Dr. Evans, the Medical Officer of Health for Bradford, informs me that amongst a list of twelve contacts there, of whom seven were outside and five in the house where the man lodged, only two were attacked, these being among the latter five, while all the seven outsiders escaped.

The above passage is from a report on 19 cases in January and February, 1905, in East Stirlingshire. In the infected houses there were twenty-one children under 10 years old, but, owing to infantile vaccination, not one of these was attacked by small-pox. If, owing to discouragement of infantile vaccination, any of these twenty-one had not been vaccinated and had developed a severe or fatal attack, I wonder what the parents would or would not have said had it been explained to them that vaccination had been deliberately omitted in order that an attack, if it occurred, might be so severe as to be recognized, in the hope of getting the case away to hospital in time to prevent infection of the neighbours' children.

Leicester.—Dr. Millard himself, in discussing the control of "contacts," divides them into two classes—"inside," living in the same house with the patient; and "outside," living elsewhere, but "who have been in the same room with the patient after he has taken ill." For outsiders, he thinks vaccination scarcely worth while, but exercises surveillance. This practice, it will be borne in mind, was based on the experience of small-pox of a remarkably mild type, with a low fatality rate, so that many of the cases would be difficult of recognition even amongst the unvaccinated.

London.—The London statistics of 1892–95 and 1901–2 are worth examining in relation to the question at issue.

The earlier epidemic was of a mild type with a fatality rate of 8 per cent. The proportion of cases "unaccounted for" in respect of infantile vaccination had in the decade

1881–90 ranged between 5.7 and 13.9 per cent., the mean of the rates being 8.5. Public health organization was improving, but was not so well advanced as in 1901–2. The later epidemic was of a severe type, with high fatality—16.8 per cent. Public health organization was better developed, and the omission of infantile vaccination had increased greatly, so that default ranged from 16.4 to 33 per cent., the mean of the rates being 24.05. London, in fact, had made measurable progress towards the ideal of cessation of infantile vaccination. In these circumstances, with a more severe disease more easily diagnosed, with less of the infantile vaccination which is complained of as making diagnosis difficult, and with administrative organization improved by a decade of additional experience, the disease in 1901–2 should, *caeteris paribus*, have been more effectively controlled than in 1892–95. But the facts were that in 1901–2 there occurred 9,659 cases, as compared with only 4,759 cases in 1892–95. London's huge population provides such a statistical basis as tends towards elimination of errors due to paucity of data, but even for London a careful survey of all relevant considerations would be necessary to justify actual conclusion, and so I content myself with calling attention to the facts set forth.

Another point to be noted is that, notwithstanding the superabundance of very mild small-pox in America and the constant traffic across the Atlantic (the journeys taking less than the incubation period), and the difficulty of diagnosis, no epidemic of the American type has been set up in this country since 1902–5.

Though in effect advocating the discouragement of infantile vaccination with a view to achieving such severity of attack as will make diagnosis easy, Dr. Millard himself aspires after mildness of type. "It is obviously," he says, "of the highest importance that the type of an epidemic should be kept as mild as possible."[5] This is more than a pious aspiration. It suggests action to influence the type of a current epidemic. It is "to be kept" as mild as possible. But by what human effort except vaccination can such mildness be secured in an epidemic? In the

Gloucester epidemic, of a naturally severe type, would not previous systematic infantile vaccination have had the effect of keeping the epidemic mild, of making the disease less fatal, and of altogether preventing hundreds of the attacks which did occur? One cannot both discourage vaccination in order to make the disease diagnosable and encourage it in order to keep an epidemic mild.

In thinking of this question of missed cases there is risk of being misled by false analogy. Every one knows that mild unrecognized scarlet fever often baffles the medical officer in endeavouring to control an outbreak. But the severity of scarlet fever and its infectivity do not run parallel as in small-pox. Failure to recognize scarlet fever by parents, with consequent failure to send for a doctor, depends mainly on the absence of the rash, whilst infection, it is now accepted, comes mainly from the throat and nasal passages. The throat may be much affected, whilst the skin has little or no eruption. Also, Dr. Mervyn Gordon, reporting to the Local Government Board, maintains that infectivity depends on one organism, but severity of attack on another. There may therefore be no difference in infectivity as between a mild and a severe case of scarlet fever.* Another false analogy relates to the old practice of small-pox inoculation. It is alleged that thereby the individual was protected but that the community was endangered, and more harm than good was done. That proposition is historically open to dispute, and the Royal Commission on Vaccination wisely held the decision in doubt. But accepting it for the moment, variolation did produce an infectious disease, whilst vaccination does not. It is true, of course, that with lapse of time after vaccination immunity diminishes. The remedy, however, is not to refrain from infantile vaccination, but to resort to revaccination.

In 1904 Dr. Millard made the following reservation: "It is possible that if practically the whole population become

* Dr. Millard, however, referring to scarlet fever, asks, "Is it not probable that the great change which has taken place in the type of the disease, in the direction of lessened severity, has been accompanied by shortening in the duration of infectivity?" (*Trans. Epidem. Soc.*, 1901-2.)

unvaccinated, the 'Leicester Method' will prove insufficient to keep the disease in check." This is a hard saying. If vaccination makes small-pox so difficult to diagnose as to do more harm than good, surely a wholly unvaccinated population would be best of all for resistance of invasion. If only 20 per cent. are unvaccinated then the other 80 per cent. may, through missed cases, spread disease among the 20; if 40 per cent. are unvaccinated, they are liable to infection from the vaccinated 60; if 80 per cent. are unvaccinated there is still a danger from the 20 vaccinated. The fact is there is no half-way nor quarter-way house. If infantile vaccination does more harm than good, then the less there is of it the better, and none at all is best of all. Since writing these words I find that Dr. Millard's views on the disadvantage of infantile vaccination have forced him to practically the same conclusion. "I honestly believe that if the entire population of Leicester were either completely vaccinated (by repeated vaccination) or completely unvaccinated the danger of small-pox would be less."[6]

Here it is necessary to bear in mind what would be the effect on the condition of the community, as a whole, of the discontinuance of infantile vaccination. Under exposure to small-pox the proportion of vaccinated persons infected is much less than of unvaccinated. The greater the total amount of vaccinal protection in a population the smaller is the number of persons liable to attack. For nine or ten years after infantile vaccination, especially if the prescribed standard of number and area of marks is adhered to, the individual enjoys a very large degree of immunity, not merely against death but against attack. In both respects the immunity continues, though in diminishing degree, for a much longer time than this, that against death being much more prolonged. The fatality rate of small-pox in childhood is exceptionally high. But it is childhood that is specially protected by infantile vaccination, and children allowed to remain unvaccinated in order that if attacked they might have an illness sufficiently severe to make diagnosis easy, would be more likely

to have a fatal attack than if the disease were deferred to later years. This would be part of the price of easier diagnosis.

The object of vaccinal legislation is, of course, to promote vaccination. If it has no such effect then it is useless and ought to be given up, still more so if on balance it in some way or other tends to discourage vaccination. These are relevant considerations for the Legislature, which also has to take a broad view in relation to the whole doctrine of the liberty of the subject. But to discourage vaccination in order that the unvaccinated individual may have an easily diagnosable (therefore possibly fatal) attack of small-pox seems to me a proposition contrary alike to the principles of medical ethics and to the interests of the public health.

There is, however, one conceivable condition which would not only justify but demand the cessation of vaccination. If small-pox were to disappear, so also manifestly would the need for vaccination. The risks attaching to vaccination were never in this country more than trivial, and calf lymph with modern asepsis has made them imponderable in weighing the value of vaccination;* but if there were no need for vaccination it would have no value, and the marvellous decrease of small-pox since the close of the outbreak with which this century began makes such a possibility, however remote still, yet apparently less remote than ever before.

REFERENCES.

[1] *Med.-Chir. Trans.*, Lond., 1853, xxxvi, 385. [2] Local Government Board Medical Officer's Report, 1874, 98. [3] BRITISH MEDICAL JOURNAL, 1894, ii, 1213. [4] *The Vaccination Question* (H. K. Lewis, 1914), and *Public Health*, Lond., 1917, xxx, 112, 128. [5] *Public Health*, Lond., 1904, xvi, 620. [6] *Public Health*, Lond., 1917, xxx, 133.

* The Royal Commission reported as to the risks that "though undoubtedly real and not inconsiderable in gross amount," still "when considered in relation to the extent of vaccination work done, they are insignificant." Since the Commission reported, the change from humanized to glycerinated calf lymph has been complete.

Lecture III.

CONTROL OF SMALL-POX IN THE PRESENT DAY.

Having discussed small-pox as it was and is, and vaccination as it was and is, we now come to the important practical question of the control of small-pox in the present day. In considering this subject it is necessary to take account alike of the attack and of the defences. As to the former, small-pox in this country is, broadly speaking, a less fatal, a less infectious and a less prevalent disease, than it was fifty years ago. The diminution (which first appears definitely in the 1892–95 epidemic), while irregular, has been fairly continuous and has been very specially notable since about 1904.

Other factors in respect of attack are that the disease is not infectious in the incubation stage, that its infectivity is limited in the pre-eruptive stage and does not reach its maximum until vesiculation and pustulation, that it is not conveyed by water supply nor by drainage, that milk epidemics are unknown, and that there are no chronic carriers. Epidemics also often begin slowly, and when that is the case there is an appreciable period within which urgent measures may be carried out by a vigilant public health authority. The several weapons in the armoury of communal defence have now to be considered.

I. Vaccination.

Vaccination and revaccination at once claim the first place. On the one hand, owing to increasing neglect of systematic infantile vaccination an increasing proportion of the population is not immune to small-pox, but on the other hand the calf lymph system of the Local Government Boards is of the first importance as a measure of defence. In the old days, as I have already pointed out, all that could be relied on in presence of the most extensive

epidemic was the exiguous supply of humanized lymph which could be obtained once a week from the arms of infants under the routine of primary vaccination at the age of three months in England and six months in Scotland. Now a huge stock of half a million tubes of glycerinated calf lymph is kept in constant readiness, fresh material being regularly added to replace material which, through lapse of time, is regarded as of doubtful efficacy. Also the vaccinal process runs a shorter course than the incubation stage of small-pox, and if the protective operation be performed within two or three days after infection, vaccinia gets home first, and variola, when it comes along, usually finds the fortress barred against its entrance. The position, however, has its disadvantages. There is always the possibility that the operation of revaccination may not be successful, and this is a risk which has to be run by the individual who has previously neglected to protect himself. Other things being equal, the work of vaccination should be done leisurely and systematically. In revaccination the convenience of the youth or adult concerned should be considered, especially with regard to the opportunity for taking a few days' rest from any heavy manual labour, to prevent inflammation around the vesicles on the vaccinated arm. Even under a system of emergency or panic vaccination this rest should be obtainable if required, especially because experience indicates that there is more likelihood of an inflamed arm in the adult than in the child. But there should be little incapacity if the vaccination has been done in cleanly fashion and is covered up with cotton-wool and boracic acid whenever it is seen that a marked reaction is to follow.

Recent Vaccination.

Vaccination or revaccination in presence of an epidemic has the supreme advantage of recency. The immunity obtained is of the highest degree. The outstanding example of the effect of recent revaccination on a large scale in this country is that of the city of Glasgow in 1901-2. Glasgow had prepared at enormous expense a

great international exhibition, and fear arose that it would prove a municipal and financial failure owing to a threatened epidemic of small-pox which would prevent visitors flocking to the city. In these circumstances the Corporation, acting on medical advice, entered on a great vaccination crusade throughout its borders. It employed and paid the whole medical profession of the city to vaccinate all who could be induced to accept the protection, and the medical officer recorded the results fortnight by fortnight. They are set down here in tabular form.

TABLE V.

Not Recently Revaccinated and Recently Revaccinated Population of Glasgow, over Five Years of Age, in each Fortnight, with the Cases of Small-pox occurring in each Class. (*Dr. A K. Chalmers.*)

	Not Recently Revaccinated.		Recently Revaccinated.	
	Population.	Cases Registered.*	Population.	Cases Registered.
1901.				
Jan. 12	675,887	23	0	0
,, 26	674,816	350	1,071	0
Feb. 9	671,025	202	4,862	0
,, 23	634,213	127	41,674	0
Mar. 9	556,561	299	119,326	0
,, 23	518,426	161	157,461	0
April 6	474,694	92	201,193	0
,, 20	429,056	67	246,831	0
May 4	384,371	28	291,516	0
,, 18	366,125	18	309,762	0
June 1	352,633	11	323,254	0
,, 15	347,777	2	328,110	0
,, 29	345,293	8	330,594	0
July 13	281,867	1	394,020	0
Nov. 16	279,452	1	396,435	0
,, 30	279,232	5	396,655	0
Dec. 14	279,020	4	395,867	0
,, 28	278,796	0	397,091	0
1902.				
Jan. 11	278,623	28	397,264	0
,, 25	278,152	23	397,735	0
Feb. 8	277,653	23	398,234	0
,, 22	277,134	147	398,753	0
Mar. 8	276,033	92	399,854	0
,, 22	274,611	85	401,276	0
April 5	272,694	36	403,193	0
,, 19	271,619	15	404,268	0
May 3	271,032	10	404,855	0

* The cases under five years have not been excluded from these figures, because their allocation through the various fortnights would have been difficult, and their inclusion is unimportant. In the 1900-1 part of the outbreak these numbered 60, 54 of whom (including 30 cases occurring under one year) were unvaccinated primarily.

It will be noted in the first column how the population not recently revaccinated was gradually diminished from 675,887 in January, 1901, to 271,032 in May, 1902, and how correspondingly the recently revaccinated population increased from *nil* in January, 1901, to 404,855 in May, 1902. During all that period the small-pox cases were also noted fortnight by fortnight. From beginning to end they were confined absolutely to the not recently revaccinated section of the population. Not a single case occurred among the recently revaccinated, and when another epidemic broke out after an interval of fully a year, only one of the 400,000 revaccinated was attacked. Small-pox prevailed especially in the eastern part of the city in which the small-pox hospital was situated, and vaccination was accordingly resorted to very freely in that area.

Money Payments.—To enable a vaccinee to take a few days' rest after the operation many public health authorities in presence of threatened small-pox now offer a small money payment, especially to the inmates of common lodging-houses or persons of the like class. I have even known of a lodger presenting himself with bared arm for revaccination who when casually gripped by the other arm demonstrated expletively that he had been very recently revaccinated and that his second presentation of himself was due to the desire for another payment. Payment is not a high class of inducement towards protection against small-pox, but in the absence of other pressure or obligation resort has to be had to the method which suits the character of the individual.

Vagrants.—In connexion with vaccination the relation of vagrants and casual workers, navvies and the like, to spread of small-pox has often been discussed. Dr. Henry Armstrong, medical officer of Newcastle, published the result of a series of inquiries concerning it in 1893. The London County Council convened a conference of sanitary authorities on the subject in 1894, and the dangerous part played by the vagrant is universally admitted. Dr. Kaye of the West Riding estimated that there were about 36,000 tramps and vagrants in England—a truly formid-

able number, with great possibilities as carriers of small-pox.

The Royal Commission in its final report in 1896 made a series of recommendations for better control of common lodging-houses in respect of small-pox prevention. Common shelters should be made subject to the law relating to common lodging-houses. Local authorities should have power to require medical examination of inmates of common lodging-houses and casual wards; to order the exclusion of fresh inmates for any required period; to close common lodging-houses temporarily; to offer free lodgings to inmates under suspicion of infectivity; should report to other sanitary authorities; and should offer vaccination to inmates.

II. Compulsory Notification of Infectious Disease.

Voluntary notification of infectious diseases was recommended in the Local Government Board's report for 1877, in which Poor Law medical officers were instructed to intimate every case, and it was advised that doctors be supplied with postcards for voluntary notification, the vaccination officers having similar instructions for intimation of cases. About this time various public health authorities were obtaining compulsory powers under local Acts. I think the first of these in England was Huddersfield in 1876. Others were Bolton, Nottingham, Jarrow, and Burton-on-Trent. Leicester followed in 1879.* In Scotland Greenock obtained powers in 1877, Edinburgh in 1879, and Aberdeen in 1881. Compulsory notification proposals were received with some hostility both by medical men and by opponents of vaccination. So late as November, 1894, the *Vaccination Inquirer* expresses its "hearty sympathy" with a medical objector to compulsory notification.

Notification of infectious disease was provided for in 1889 by an Act which local authorities could adopt if they

* Dr. Millard, who ought to know, makes a puzzling statement as to Leicester. He says: "Compulsory notification came into force under a local Act as early as 1878."[1] But the Act was not passed until August 11th, 1879, and the Royal Commission say (par. 481, Final Report) that it came into operation after that year.

so desired. It became compulsory in 1899, and is essential alike to the successful practice of emergency vaccination and to all supplementary measures for dealing with small-pox epidemics. Obviously to control a serious infection one must first be aware of its existence. Fifty years ago the knowledge which came to the public health officer was at the best casual and fragmentary—so casual and so fragmentary as to make impossible the stamping out of an epidemic otherwise than by general vaccination and re-vaccination, whilst these measures, as already indicated, were strictly limited by insufficiency of humanized lymph. Now the case is widely different. There is no disease of which the medical practitioner is more certain to give immediate notification than of small-pox, actual or suspected. Notification, of course, should be prompt, and the telephone or telegraph should be freely used in addition to written intimation to the medical officer of health.

Diagnosis.

As a preliminary to notification, diagnosis is obviously essential. But there is little opportunity in the present day for instruction of medical students, and the longer this remains at a minimum the better it is for all concerned, as it means that small-pox is absent. Such opportunity, however, as does exist should be fully taken advantage of, and wherever a case of small-pox can be seen students and practitioners within reach should be given, under due precautions, facilities for seeing it. Fortunately, as the result of action taken by the Royal College of Physicians in 1887, the institutions of the Metropolitan Asylums Board are now available for the education of students. The great hospitals for infectious diseases throughout the country are similarly at the service of the medical schools. In presence of actual outbreaks an excellent practice has been established by the Local Government Boards of England and Scotland of assisting any local health authority which has to deal with small-pox by giving them the aid of a medical inspector specially acquainted with the subject. Advantage

should be taken of this service not only for diagnosis but for the whole scheme of preventive measures.

It has been pointed out to me by the Superintendent of the Edinburgh City Hospital that, in the absence of small-pox, useful clinical teaching in the diagnosis of that disease can be given where chicken-pox chances to be in the wards. Many hospitals do not intentionally admit chicken-pox, but cases often occur in children's wards for other diseases. Not only can the situation and character of the chicken-pox eruption be demonstrated, but also, by way of contrast, the skin areas where the eruption of small-pox would have been likely to be found.

Attenuation of type, now so common, has altered the criteria of diagnosis. Formerly, the main distinction between variola and varicella was anatomical, depending on the different characters of the pustules—shotty, umbilicated, multilocular, deep-seated, regular in shape in small-pox, and the opposite of all these particulars in chicken-pox. Now, however, in mild small-pox the pustules are sometimes practically indistinguishable from those of chicken-pox, and dependence has to be put mainly on the distribution of the eruption. This can be taught negatively at the bedside from a case of chicken-pox, and the monographs on the diagnosis of small-pox by Ricketts and Wanklyn can be consulted for details.

When once a medical officer has made up his mind, say as between small-pox and chicken-pox, he should not hesitate to act on the conclusion reached, and circumstances may quickly show whether he is right or wrong. On one occasion in a small house in a tenement building I concluded, after some difficulty, that a case which the medical attendant asked me to see was chicken-pox and not small-pox. There was no hospital accommodation for chicken-pox, and so the patient was treated at home. The household contained several young children and several adults. Isolation was impracticable. If the disease were small-pox, the children, having been vaccinated in infancy, would escape, whilst the adults not having been vaccinated

since infancy might have mild attacks. If, on the other hand, the disease was chicken-pox, it would spread amongst the children, whilst the adults who had in childhood passed through chicken-pox would escape. The incubation period of the two diseases is similar, and I awaited the *denouement* not without anxiety. In due time the children developed chicken-pox, and the adults remained unaffected, so my mind was at rest.

III. Public Health Staff.

The next great difference between the past and the present consists in the vastly improved public health staff now employed by the very great majority of local authorities. In 1870 there was not in Scotland a single whole-time medical officer of health. For the rest, each so-called public health authority gave a more or less nominal appointment to some doctor in general practice, commonly without any special study or knowledge of hygiene or disease prevention. Diplomas in public health were not instituted for a good many years after 1870, and even yet the possession by a health officer of such a diploma is not invariable. They are mentioned in this connexion merely as indicating the education and training in the prevention of infectious diseases which are now obtainable. If one looks at the list of textbooks and publications of all sorts which have come into existence in relation to public health and compares it with the meagre literature of 1870, an indication of the changed conditions is obtained. In the early days of public health diplomas bacteriology was hardly even a rudimentary science, and the laboratory part of the practical examination was confined to chemistry and microscopy. Bacteriology, unfortunately, has, so far, been of little value in respect of small-pox, but the place it now occupies illustrates the tremendous improvement that has taken place in the equipment of the public health staff of a local authority. Almost every day whole-time appointments are being substituted for part-time, and comparatively soon this advance will be com-

plete. The medical officer, besides, has now a staff incomparably better than existed, or could have existed, in 1870. Just as education for the diploma in public health has advanced, so has education of the sanitary inspector, who displaces the old inspector of nuisances.

Let me say in a word on this point that the outstanding insanitary condition which can be regarded as of consequence in spreading small-pox is overcrowding. Propinquity of individual to individual within dwellings undoubtedly favours extension of the disease, and the system of high tenement buildings giving accommodation to many households and approached by a common turnpike stair makes small-pox, once it has obtained a footing, very much more difficult to control in a city like Edinburgh or Glasgow than in any English working class town with houses only two stories high and each dwelling with its own door opening directly on the street.

IV. Surveillance of Contacts.

Search for small-pox contacts was no doubt attempted to some rudimentary extent even in the pandemic of the Seventies. In 1878, referring to a report by Dr. Johnson, assistant medical officer of Leicester, in which he describes quarantining of contacts, the British Medical Journal says Dr. Johnson is in error in thinking his plan novel, as it had been practised in the metropolis and elsewhere, not only for small-pox but for cholera. The Journal agrees that it is undoubtedly very useful at the commencement of what might otherwise have been an epidemic, and is worthy of being more extensively carried out. In cholera difficulty had been experienced in getting fathers into quarantine unless they were out of employment, "and then at least equal difficulty was experienced, at any rate in some places, in inducing them to leave the comfortable quarters provided." The practice thus seems not to have been confined to a single locality, but to have been more or less common. Obviously, however, observation of contacts could only be very imperfectly carried out in the absence of systematic notification of cases.

The epidemic of 1892–95, following as it did the passing of the (adoptive) Notification Act of 1889, furnished really the first opportunity for systematic surveillance of contacts on any extensive scale, and reports show that it was practised in many places: Warrington, Chadderton, Liverpool, Leeds, Oldham, Crewe, Stafford, Bradford, Gloucester, Leicester, Halifax, Sheffield, and Salford may be mentioned.

Under notification, surveillance is a routine duty of the most essential importance, and here the value of a trained and active public health staff becomes manifest. When the first case is discovered, and while it is being dealt with, the question of its origin is simultaneously investigated. The movements and doings of the individual before the development of the eruption, and for a day or two on either side of it, have to be rigidly investigated, and if the source of his infection is discovered it becomes a new centre of similar inquiries. Next the patient has to be questioned as to his movements during the period of possible infectivity. The household claims the first place, and if he has been an inmate of a common lodging-house, the household is a large and difficult one. His place of employment, workshop or factory, has next to be thought of, also houses which he has visited—meetings, churches, reading-rooms, libraries, educational classes, public-houses, and so forth. All these have this in common, that they give opportunity for indoor infection. As already argued, I am satisfied that, especially in a mild type of disease, indoor infection is much more to be feared than outdoor. Yet if the medical officer of health has succeeded in fixing the patient's memory on his doings on the days in question, and if he can get him to tell the whole truth, note should be made of casual conversations on the street, or of contact in open-air workplaces, especially where the patient's eruption is abundant and where diagnosis has not been made until the stage of vesiculation and pustulation.

A list of contacts having been prepared in this way the necessary action—immediate offer of vaccination, and surveillance—is taken with regard to them. It is by no

means necessary that all of them should be seen daily for a fortnight from the discovery of the case. The date of contact should in each case be noted and the surveillance should have relation to the date. Contacts should be dealt with as human beings whose liberties are not to be needlessly limited. Round about the day on which the disease may be expected to appear there should, of course, be special vigilance. A well vaccinated and revaccinated man, after disinfection of his clothing, etc., need have no restrictions whatever put on his movements because he was a contact. A doctor should not be the only privileged person in this respect. And even for others less well vaccinated it is unnecessary that daily work should be abstained from excepting on the critical days, but warning should be given of the necessity for at once making intimation of the slightest symptoms of illness, usually backache and headache. There is at present no power to compel contacts to remain under conditions permitting of regular observation. They may roam the country as they please, and to deal with this difficulty special measures have to be thought of. In common lodging-houses the money factor comes in as in the case of vaccination of vagrants. It will profit the community to pay casuals to remain where they can be found at any time.

Reception Houses.—In large towns reception houses are very useful and they should have accommodation not only for individuals but for families. They have to be maintained, of course, by the public health authority. In the country reception houses are much less necessary and individuals can commonly be kept under observation at home.

School Closure.—The closure of schools in small-pox, as in the case of other infectious diseases, is a question of circumstances, and the practice may differ according to the facts. I have never myself had occasion to close a school for small-pox, and, as noted by Dr. Killick Millard, it is easier to keep under observation children in a school, especially from a central locality, than to visit them at their own homes. But, on the other hand,

an unrecognized case in a school may have opportunity of spreading the disease into localities which would not otherwise be under risk of invasion. The question, as I have said, is one of circumstance, and vigilance is always necessary.

What small-pox may do when it finds entrance into a school is strikingly illustrated in the experience of the Borough of Ossett during the epidemic there.* An unvaccinated child attended school whilst suffering from small-pox. In her class were 27 children, of whom (*a*) 6 had been vaccinated and revaccinated, (*b*) 13 had been vaccinated only in infancy, and (*c*) 8 were unvaccinated. All those under (*a*) and (*b*) escaped attack. All those under (*c*) were attacked. In the same room were other 42 scholars, of whom (*a*) 8 had been vaccinated and revaccinated, (*b*) 20 had been vaccinated only in infancy, and (*c*) 14 were unvaccinated. All under (*a*) escaped attack, 5 of those under (*b*) were attacked, each of them being over 11 years old, and 12 of the 14 under (*c*) were attacked. In other two rooms were 100 scholars, of whom (*a*) 45 had been vaccinated and (*b*) 55 were unvaccinated. All the 45 under (*a*) escaped attack, and 17 of the 55 under (*b*) were attacked. The type being mild, all recovered.

The difficulties of dealing with contacts are increased by the size and character of a community and by migratory habits of its population. In the east end of London one would expect control to be more difficult than in a residential part of the metropolis. Needless to say, every contact, whether intimate or remote—and contacts may be usefully so classified—should be advised to accept immediate vaccination unless he is already sufficiently protected. But pressure towards vaccination should never be excessive. The policy of Parliament to yield to strenuous objection should be borne in mind, and sometimes it turns out profitable not to have pressed too much. I have succeeded in vaccinating a whole village streetful

* Reported by Dr. Kaye of the West Riding County Council, and Dr. Greenwood, Medical Officer of Health, Ossett Borough, and quoted by Dr. Spencer Low in his report on the Dewsbury epidemic of 1904.

of people as a result of development of small-pox by a contact who had ostentatiously refused protection.

V. Isolation of Small-pox.

One of the earliest advocates of isolation as a supplement to vaccination was Sir James Y. Simpson in 1868, in a paper entitled "Proposal to Stamp Out Small-pox, etc."[2] Simpson stated that "In despite of the marvellous protective influence of vaccination, the mortality produced by small-pox in Great Britain is still very great and startling," and that "Jenner's immortal discovery saves from death from small-pox in our present population in Great Britain probably about 80,000 lives yearly," but that "there still die from its ravages about 5,000 annually." Concerning these he wrote that "doubtlessly a stricter enforcement of the new compulsory laws of vaccination, and a greater amount of attention to its proper performance with proper matter, will betimes diminish the number of the susceptible class." "Yet, in the meantime," he goes on to say, "the disease still revels with fatal power," and he asks, "can it be arrested in its progress?" He believed it could, and proposed four regulations, which were briefly: (1) "The earliest possible notification"; (2) "The seclusion, at home or in hospital, of those affected"; (3) "The surrounding of the sick with nurses and attendants" immune by cow-pox or small-pox; and (4) Disinfection. He attached chief importance and devoted the rest of his paper to "seclusion," or isolation, which, it will be observed, might be conducted either at home or in hospital. Concerning infectivity he writes: "As the disease does not mature into the stage of infection for some days after the eruption shows itself, a free period would thus be secured to arrange proper measures of isolation, either at home or in hospital, before the date and danger of infection was reached."

In his opinions as to infectivity Simpson was mistaken, almost as Haygarth of Chester had been in the eighteenth century, but excepting that he makes no mention of contacts, his whole scheme shows a characteristic grasp of essentials. I have stated his views here because of the

grave risk which exists that the opinions of so great a man on so important a subject may be seriously misunderstood by readers who do not turn for the facts to Simpson's own writings but accept second or third hand references to them. Simpson's "Proposal" was brought before the Royal Commission on Vaccination by a witness who gave no hint either by quotation or reference that the paper contained any mention of vaccination. The dissentient Commissioners in their Statement say that Simpson's paper "will be found at page 40 of the fourth volume of our reports." They believed so, but in fact the paper is not there. What at a casual glance appears to be the paper is there, but it is not the paper as published by Simpson, all the above important references to vaccination being absent. In a review of the dissentients' Statement[3] I pointed out with some fulness the misleading manner in which Simpson's "Proposal" was placed before the Royal Commission. In the next place, just as the dissentients relied on the evidence of the witness in question, so Dr. Millard, in a brief passage in *The Vaccination Question*, relies in turn on the dissentients' Statement, and, whilst quoting Simpson as to "stamping out," makes no mention of the fact that the proposal related to cases occurring amongst the fraction of the population left unprotected by vaccination. So the omissional error is perpetuated.

Other authorities who have urged the value of isolation hospitals are Dr. George Buchanan in 1874, and Dr. Thorne Thorne in evidence given before the Royal Commission which inquired into small-pox and fever hospitals in London in 1881–82, but the views of Buchanan and Thorne as to vaccination are so well known as to prevent any risk of misapprehension, at least for another generation.

Meantime, while isolation was being advocated by Simpson, Buchanan, and Thorne, it was being denounced by opponents of vaccination no less violently than was the Jennerian "rite" itself. In 1877 it was urged in one of a series of officially issued Vaccination Tracts that "small-pox hospitals are the culminating mistake in the social treatment of the disease. They are sewers of death to

their inmates"; and so late as 1894 the *Vaccination Inquirer* declared itself strenuously opposed to compulsory removal to hospital. Now, however, isolation is advocated by antivaccinationists as if it were a discovery of their own and could be a substitute for vaccination. The Royal Commission tersely summed up the situation when they said regarding isolation, "what it can accomplish as an auxiliary to vaccination is one thing; whether it can be relied on in its stead is another thing."[4]

Hospitals.

As I have said elsewhere, small-pox hospitals are in a peculiar position in relation to prevention of the disease. If vaccination and revaccination were universal there would be no need for small-pox hospitals. On the other hand, if vaccination were absent, small-pox hospitals would be useless, unless, indeed, the whole staff connected with isolation measures—the medical officers, the sanitary inspectors, the ambulance drivers, the nurses, the hospital attendants, those who bring provisions to the hospital, and all connected with it—had already suffered from small-pox and had in that way achieved immunity. It is in the intermediate condition, with vaccination not universal, yet available, that small-pox hospitals find their place in the system of prevention.

Their Situation.—But when they began to be used on any appreciable scale in London and in Glasgow in the epidemic of the Seventies it is true to say that they did much more harm than good. The hospitals became centres of infection from which the disease spread throughout the community. Gradually this lesson was learned, sometimes with reluctance and often with disputation as to the nature of the hospital influence, whether aërial or by contact. Epidemiologists should read the report in the *Transactions* of the Epidemiological Society (vol. xxiv, 1904–5) of a two days' discussion on "The spread of small-pox occasioned by small-pox hospitals during the epidemic period 1900–1904, and its relation to atmospheric convection." There has been no opportunity

of studying the question since 1904, and just possibly there may never again be a chance of having the hypothesis tested. But in fact the position now generally is that small-pox isolation hospitals are themselves isolated from the general community in addition to isolating the patients within them. With extension of rural housing and re-development of agriculture isolated sites may become more difficult to obtain, but a motor ambulance service enables a single well-situated hospital to serve a large area.

Their Accommodation.—Not only is the position of such hospitals of importance, but so also is the amount of their accommodation; and here it is practically impossible to state how many beds may be required for a given population in presence of an epidemic, so much depends on factors which cannot be measured. The infectivity of the disease, the promptitude and skill which are exercised in grappling with it, the circumstances of the locality in which it occurs, and so forth, are all important factors in the position. The course to adopt, therefore, is not to erect any very great amount of ward accommodation, but to have as the centre of the hospital scheme an administrative block which will serve for a large staff, and a large amount of ward accommodation. Also, there should be sufficient ground attached to the hospital to permit of quick extension. The situation of possible future ward blocks should be definitely laid out and the ground prepared so that so-called temporary buildings can be quickly erected. For small-pox I have always preferred that ward pavilions not expected to be often in use should be constructed of wood and iron. Such materials do not gather damp as sandstone does, and are more easily heated up and put into proper condition for occupation.

Their Management.—It is necessary to go into a little more detail here. Assuming the hospital to be in a safe situation, thoroughly competent management can go far to removing risk of danger. Vaccination again takes the first place. The staff, both resident and visiting, should be rendered immune; so should ambulance drivers, and all, such as carriers of provisions and stores, gardeners, etc.,

who have any reason to visit the hospital. Steps have to be taken also to prevent the conveyance of infection indirectly, as by clothing or person. The ambulance van in a city should not use busy streets liable to blocking of traffic when curiosity would gather passers by around the van. Quiet unobstructed side streets should be chosen for rapid transit. Theft from the hospital laundry should be carefully guarded against. Emergency nurses should not be employed, but only the trained and trusted staff who have been engaged in nursing other infectious diseases for the public health authority. It is an excellent arrangement, as under Dr. Claude Ker in Edinburgh, to get the nursing staff to forego their usual daily or weekly leave. They should be encouraged to remain within the grounds for a month or even more, and then there should be thorough disinfection prior to several days' continuous leave. The usual precautions as to overalls and caps should, of course, be observed. Goods for the hospital should be brought only within the gate and then taken in by the resident staff. There should be a separate gate for such traffic independently of the patients' gate. Letters regarding patients and official communications of any kind should be dictated by telephone to the local health office and then transmitted in writing. Visits to patients should be strictly limited, though in the case of a dying patient a visit cannot be refused, even if the visitor declines vaccination. He can at least be protected by overalls and subsequently dealt with as a contact.

Emergency Arrangements. — Small-pox should have a hospital to itself, but sometimes even yet local authorities are not so provided, and a safely situated hospital for ordinary infectious disease has to be utilized. In presence of small-pox in a county area I have repeatedly arranged for several local authorities to devote one of their institutions to small-pox, and for ordinary infectious diseases belonging to the district served by it to be treated at other hospitals in the county. This is made easier in practice by the fact that in the early stage of the disease at which a case is ordinarily diagnosed, the patient can safely be

removed for quite a long distance in an ambulance wagon; and of course motor ambulances reduce the difficulty to a minimum. Where, however, circumstances make it necessary to treat small-pox in a hospital containing cases of other diseases, the position need not be despaired of. The vaccinal condition of all patients can be ascertained, and permission asked to vaccinate those who require it. If this is refused in any case the patient may probably be in a condition permitting discharge from the hospital, preferably to another hospital. Sometimes, however, a patient may be too ill for vaccination, and a certain amount of risk may be unavoidable. If so, it is part of the price that has to be paid for lack of vaccination or of a separate small-pox hospital. In Leicester, after its Method was departed from, in addition to having a small-pox hospital, the expedient was resorted to of commandeering, for small-pox, the whole of the ordinary infectious diseases hospital, by sending home all removable cases, whatever they might be suffering from. This was followed in 1892 by an extensive epidemic of scarlet fever. On another occasion in the same town such extension did not take place. Anyhow it will be agreed that small-pox is more to be feared than scarlet fever, and should have preference in isolation.

Ineffective Isolation.—Where a small-pox epidemic gets out of hand it quickly becomes futile to attempt to control it by hospital isolation, and efforts to do so are pitiably ineffective. Gloucester, Dewsbury, and Middlesbrough are cases in point.

Gloucester, taking Leicester for its guide, neglected vaccination, and surpassed even its mentor in the degree of its neglect. Also, its representatives told the Royal Commission about the cleanliness of their fine old city and called attention to its freedom from small-pox. Then when its trial came in 1895–96, though as a town of only 40,000 inhabitants it had not available the whole time of a medical officer, as Leicester had with its 200,000 population, yet with its 48 beds it had much more hospital accommodation in proportion to its size, and it set out to follow the

Leicester Method.* But its type of infection, unlike Leicester's, was severe, and though this made diagnosis easier, the epidemic spread. After exhausting, and more than exhausting, its 48 beds it went on adding to its provision, so that in the end it had no less than 318 beds. But all was of no avail, and it had to fall back on vaccination and revaccination, ending its experiment by becoming the best vaccinated town in the British empire. Regardless of consistency, antivaccinationists have ever since then attributed the epidemic to insanitation.

Dewsbury, likewise defying vaccination and defying common sense in respect of every preventive measure, hopelessly failed by panic provision of hospitals to quell its epidemic.

Even *Middlesbrough* (population 90,000), with infantile vaccination extensively practised, but without systematic revaccination, and with a severe strain of infection in its epidemic of 1897–98, gradually increased its small-pox accommodation from 14 beds to the remarkable total of 822 beds; and in the end, as bewailed by the medical officer of health, they had "twenty-two blocks of temporary buildings which nobody knows what to do with, besides an enormous amount of bedding, beds, and other

* The Gloucester method was thus reported on to the Royal Commission by Dr. Sidney Coupland: "I was informed by Dr. Campbell that the following was the procedure adopted at the earlier period of the epidemic with regard to all cases of small-pox. On receipt of the notification the medical officer of health visited the house, confirmed the diagnosis, and directed the sanitary inspector to remove the case to hospital. Removal was in all cases promptly done. The bedding, carpets, etc., in the rooms occupied by the patients were destroyed by the sanitary authority, and compensation granted by the sanitary committee of the town council. The remaining inmates of the house were kept at home under 'quarantine' surveillance for a period of fourteen days after the removal of the case. Or, if the case were not removed, the 'quarantine' was prolonged until fourteen days after the patient had been declared free from infection. After the close of the quarantine period, the house was disinfected by the sanitary authority. The room which had been occupied by the patient was sprayed with mercuric chloride solution and fumigated with sulphur for a period of six hours. The windows and doors were then thrown open and the floors cleaned with carbolic soap. The ceilings were limewashed and the walls mostly repapered." As regards promptitude of isolation, Dr. Coupland shows that not until the sixtieth removal to hospital was there a delay of a single day, and then the delay was of one day only.

materials." Under such conditions house to house visitation for vaccination and revaccination is the only means to control an outbreak.

VI. Disinfection.

The object of disinfection is, of course, the destruction of the poison, and this ought always to be complete. It is a routine measure, and the modern methods available are well understood and thoroughly effective. Pawnshops and laundries may require attention where articles have been received from infected houses. In towns, shelters may conveniently be provided for poor persons whilst their houses are being disinfected. For security, articles which are difficult to disinfect, such as bedding, are not infrequently destroyed, and so the mind of the authorities is relieved of all anxiety on that score. A hospital superintendent of great experience has advised me that soaking of blankets, etc., in soap and water seemed to destroy all infection. Where a navvy or a vagrant has occupied two or three different beds in a navvies' hut or common lodging-house with many inmates, disinfection is difficult and destruction expensive, but no necessary measure must be shirked on either ground. Not only may a lodger or navvy have occupied in succession two or three different beds, but there may be in succession several introductions of the disease during an epidemic period, and the difficulty is manifest of carrying out thorough disinfection in the same lodging-house or hut time after time, perhaps at a few days' interval.

VII. Local Co-operation and Central Co-ordination.

A duty that should not be neglected is to notify local authorities in the neighbourhood, especially if any contacts are supposed to have travelled into their area. The date of exposure to infection of such contacts should always be stated to the medical officer so as to guide his action. If in any case there has been an exodus of navvies from constructional works or of vagrants from a lodging-house, the police of surrounding areas, as well as the medical officers of health, should be informed and a search instituted for

contacts. Often the name of the navvy in such circumstances is of no avail. Some of them for various reasons seem to use a new name for every new job.

Dr. Boobbyer of Nottingham adopted a very systematic scheme of notification to various parties within his own area who might utilize information sent to them. The name and address of every fresh patient was furnished daily to general and special hospitals, to the post-office surgeon, the Charity Organization Society, the guardians, the Education Committee, the city librarian, the health visitor, the owners or rent collectors of infected houses, the vaccination officer and public vaccinator, and various municipal officers.

Under orders by the Local Government Boards of England and Scotland every small-pox case individually is to be reported as it occurs. The army, navy, and air force authorities are notified at once if concerned, an inspector is usually sent, and necessary inquiries are carried back to other districts or other countries. Small-pox abroad is followed to the extent that information allows, and port medical officers are told of any known special risk. Last year at Newcastle a shipload of refugees from Murmansk in Russia was medically examined, and four or five cases of ambulant small-pox were found which would otherwise have got to destinations within the country. Similar inspections have been made at Aberdeen by the Scottish Local Government Board. The resumed traffic with the North Sea and Baltic ports is being closely watched.

These, then, are the essentials of the modern method of small-pox control: (1) A large supply of glycerinated calf lymph constantly available, capable of immediate increase, and freely used for all who will take advantage of it; (2) compulsory notification; (3) a sufficient public health staff; (4) search for, vaccination of, and surveillance of contacts; (5) isolation; (6) disinfection; and (7) local and central administrative co-operation and co-ordination.

Excepting for two features, these preventive measures, as such, are not new. They are not even modern. In a review of the Public Health Administration of Glasgow[5] the late Dr. Hugh A. M'Lean showed that so early as 1648 the precautions set forth for the prevention of plague were, when translated into modern speech, briefly as follows:

"1. Compulsory notification.

"2. House-to-house visitation; districts mapped out, and certain quartermasters or sanitary inspectors appointed to each.

"3. Compulsory removal, rich and poor alike, to the isolation camp on the Town's Moor, with corollary of treatment and upkeep at the town's expense.

"4. Appointment of a superintendent to manage the camp, with visitation by a councillor twice or thrice weekly.

"5. Cleaning of infected houses and clothes, and removal in special closed carts of infected filth."

The two new items in the modern scheme of prevention as applied to small-pox are (1) vaccination, or immunizing of the individual, and (2) observation of contacts, based on present day knowledge of incubation periods during which infectious disease can be dealt with before the stage of infection is reached. These embrace the essential advances in principle which have been made within the past three hundred years. The rest is improvement in practice.

A Navvies' Small-pox Outbreak.

In illustration of the experiences and problems—difficult, but stimulating—which small-pox may bring to the health administration of a rural area unprovided with the preventive equipment of a town, I may give a brief account of an outbreak amongst navvies in the winter of 1892–93. A new railway—the West Highland—was being constructed in Dunbartonshire, along the shores of the Gareloch, Loch Long, and Loch Lomond, and hundreds of navvies were employed at a time when small-pox prevailed extensively in the industrial parts of Scotland. On

December 26th, 1892, a message came to me from the Glasgow Health Office that a tramp suffering from small-pox had been found in a lodging-house, and that he had just come from Ardlui, a small scattered hamlet at the head of Loch Lomond, where he had been staying for several days. I wired to the nearest doctor on Loch Lomondside—at Tarbet, about ten miles away—to visit immediately, and set about collecting vaccine lymph preparatory to visiting on the following morning. There was a steamer service on the Loch only three days a week.

The tramp had stayed for several days in a navvies' hut used as a lodging-house. There were 19 inmates and the incubation period had about half elapsed. Note was taken of the vaccinal condition of the 19, and I arranged that the Tarbet doctor, who was also doctor to the railway constructional works, would visit daily and watch for appearance of the disease. The railway contractors were asked, and agreed, to refrain from dismissing any of the navvies in the hut, and to employ them in a gang by themselves. Two, however, had already gone away, and were searched for by means of the police in half a dozen adjoining counties and burghs. Both were found. One had previously had small-pox, and neither developed the disease.

Meantime the hut was disinfected and the infected bedding burned, but the problem which troubled me most was what to do with any small-pox which might develop. The nearest available hospital was at Knightswood, close to Glasgow, and forty miles by road from Ardlui. Conveyance of small-pox cases by the steamer service was not to be thought of, and the onset of a heavy snowstorm answered in the negative the question whether Knightswood Hospital could be approached by road. I resolved therefore—and there was no time for deliberation—to start a hospital and observation house on Loch Lomondside. The navvies' lodging-house was secured for the former purpose, and another hut not far away was obtained as

a reception house, the ordinary navvy inmates being sent elsewhere. Staffing and equipment were the next problem, though all questions were really being tackled at the same time, with the help of Mr. Dunbar, the county sanitary inspector, who gave invaluable assistance. The observation hut was put in charge of a navvy who had been in the army, and maintained discipline. No nurses could be obtained in Glasgow, but the ex-matron of a small local hospital was found in the Vale of Leven, at the south end of Loch Lomond, and undertook the job with such help as was obtainable. A retired sanitary inspector, not in his first youth, was also enlisted in the service, and, under the name of "Sanitas," which somehow was at once given to him in the locality, he did excellent work, though on one occasion his supervision of the funeral of a patient who had succumbed to small-pox had results which would have needed some explanation had an intelligent press got hold of the facts. It required the aid of three men and three bottles of whisky to accomplish the obsequies of that navvy. One of the mourners was so overcome that he fell into the grave on the top of the coffin, and subsequently conveyed small-pox to a neighbour who had no other kind of contact with the outbreak. Such a funeral introduced what is now called "a certain liveliness" into the proceedings, and some restraint had to be put on local enthusiasm. The thrice-a-week steamer service was quite insufficient for communication purposes, and a night drive in an open trap along the frozen roads from Glen Falloch to Balloch was the coldest experience I ever had. A motor launch with its engineer was hired for the period of the outbreak, and served for conveyance of bedding, furniture, food, and other supplies, and also of the staff.

These arrangements were not wholly made in advance, but matured contemporaneously with the occurrence of cases of small-pox. On January 2nd and 3rd three of the navvies developed the eruption. A man who had been twice vaccinated and had had a day or two's feverishness without eruption was retained as attendant,

and the wife of the hut-keeper was also pressed into the service.

The Tarbet doctor took medical charge of both huts. A son of the keeper of the original (by that time the hospital) hut was one of the inmates of the observation hut, but refused revaccination and disobeyed strict injunctions not to visit the hospital hut. He duly developed small-pox and was transferred to the hospital hut. Two or three persons had been indirectly exposed to infection from the case of the tramp and two developed the disease.

Another centre of infection was meanwhile discovered at a navvies' hut at Ardencaple on the Gareloch. On January 10th the hut-keeper developed the disease and was removed to Knightswood Hospital, the distance being about twenty miles. Infection had been by a tramp on his way north to Crianlarich in Perthshire. I wrote to the Perthshire medical officer warning him to be on the outlook for small-pox at Crianlarich, but received the same day a letter from him warning me about Ardencaple. On the side of Loch Long, midway between Ardencaple and Ardlui, was another navvies' hut which also became involved by tramp infection, and as it was only nine or ten miles from Ardlui, the hospital hut there served for a case which occurred. Whilst visiting the Loch Long hut I found an inmate engrossed in reading the *Fortnightly Review*. Many a navvy, like this man, has a life story which he will not reveal.

The public health authority sanctioned the use of re-vaccination to the utmost in control of the disease, and, employing the doctor at Tarbet, the operation was, I believe, performed on every one of 600 navvies working on the railway track in Dunbartonshire, with the exception of such as were already immune through small-pox or revaccination.

The total cases in the outbreak amounted only to 12, with 2 deaths.

Regarding vaccination, I reported as follows:

Of the nineteen inmates of the hut at Ardlui, three had already had small-pox and none of these were attacked; four had been

either revaccinated or their primary vaccination had been performed subsequently to the age of 12 years, thus making it equivalent to a revaccination, and none of these were attacked by small-pox, though they included the man referred to who had a slight febrile illness. Of the remaining twelve, one had four marks of vaccination, two had two marks, six had one mark, and two had no traces of ever having been vaccinated. None of those who had more than one mark were attacked. Of the six who had one mark two were attacked, and of the two who had no marks, both were attacked and one died.

The facts as to the vaccination or non-vaccination of these nineteen persons were taken down by Mr. Dunbar to my dictation on my first visit on 27th December, previous to any of them having developed small-pox.

Such an outbreak involves much hard work to those responsible for its control, and calls out all the initiative a man possesses, but the results far more than repay the labour. The scene was set in the wilds, beside lochs and frozen streams and snow-clad mountains. The whole experience made an unforgettable impression, and was an unequivocal demonstration of the value of vaccination, supplemented by emergency measures of isolation and observation of contacts.

[I feel impelled to digress. The West Highland is the finest scenic railway in this country. What a single day's train travel can reveal of grandeur and beauty may be learned by any one who, after a very early breakfast, goes right on from Queen Street Station, Glasgow, to Fort William, or, still better, to the western shore at Mallaig, whence, after a quick lunch, he starts on the return journey, and arrives back in Glasgow the same evening.

After leaving Clydeside he will look down on the sheltered waters of the Gareloch, then on the deep, narrow channel of Loch Long, with Ardgoil and the peak of The Cobbler beyond; next he will pass by Tarbet (the "place of dragging" where boats were hauled overland from one loch to another) to Loch Lomond, with one aspect of the Ben filling the sky line on the eastern side, then up Glen Falloch into Perthshire by Crianlarich, where, crossing the almost equally grand

Callander and Oban Railway, he is carried through a wide, hill-encircled strath towards the Moor of Rannoch, the scene of that long, weary tramp of Alan Breck and David Balfour, as told in Stevenson's great story. Next he passes by the steep banks of Loch Treig to Glen Spean, where the line turns westward to Fort William. After a few minutes' stay there the Caledonian Canal is crossed to Corpach, from which the huge heavy mass of Ben Nevis (a peakless mountain) is best envisaged; next through the romantic land of the Camerons of Locheil to Glenfinnan, where, at the head of Loch Shiel, there comes into view for a moment the monument built to Prince Charlie in the field on which he gathered the clans for the hapless enterprise of the "Forty-five"; then by Loch Eilt and the Sound of Arisaig to Morar and Mallaig. If the weather has been wet—as is too often the case—there is the compensation of Highland torrents brawling in peaty foam along the rocky beds of the many streams bordering the railway line. On the return journey reversed viewpoints prevent any staleness of outlook; and so, after some fourteen hours' travel, there is reached again the great city on the Clyde which, though cursed always with smoke and often with rain or fog, has the most splendid and spacious hinterland of any town in the British Isles.]

Leicester and Small-pox.

It is impossible to complete a survey of the present-day control of small-pox without reference in some detail to what has come to be known as the Leicester Method of dealing with the disease.

The usual antivaccination history of Leicester is that prior to 1872 it was a well vaccinated town, and that after having suffered from the epidemic it abandoned vaccination. The facts, however, are very different. Before 1872 Leicester had been notorious for its neglect of vaccination, as appears, indeed, from statements made by exponents of Leicester's methods. In 1842 the guardians decided not to carry out the Vaccination Act of 1840, and in 1851 not half of the inhabitants were vaccinated. Lord Lyttleton,

in introducing the Vaccination Act of 1853, cited Leicester as an example of neglected vaccination. A table of statistics of vaccination submitted to the Royal Commission by Mr. J. T. Biggs on behalf of Leicester showed a large average default excepting for the years 1868–71. As regards the period subsequent to 1872, at a census of the vaccinal condition of a typical population of over a thousand people, taken in 1903, it was found that about 62 per cent. had been vaccinated, though no doubt many of the vaccinations would be of old date.

Mr. Biggs's table of statistics just referred to will be found at page 465 of the Fourth Report of the Royal Commission on Vaccination. Dr. Killick Millard in "The Vaccination Question" (page 222A) gives a table to show *inter alia* the vaccinations in Leicester from 1838 to 1913. His figures from 1849 to 1839 are identical with those in Mr. Biggs's table, yet if used for comparison with other places they are misleading. Mr. Biggs explains that for the years 1849–62 inclusive he added twenty per cent. to the public vaccinations in order to represent private vaccinations as to which there was no official information in existence. But Dr. Millard inadvertently omits this explanation in giving the same figures (which he wrongly speaks of as "the registered vaccinations") and he describes a deficiency of about thirty per cent. merely as "a certain amount of vaccination default in Leicester" prior to 1868, which he says "was also the case, no doubt, in most other towns."* Obviously a due addition for private vaccinations would have to be made in the case of other towns if any comparison were attempted. The thirty per cent. default at the period in question applied to Leicester after the addition for private vaccinations was made. Dr. Millard—who is not an anti-vaccinationist—declares† that "prior to the year 1871 Leicester ranked as a well vaccinated town," and Mr. Biggs made the statement‡ "the epidemic of 1871–3 found a fully vaccinated population in Leicester both

* Loc. cit. p. 115.
† *Public Health*, February, 1917, p. 115.
‡ Leicester: *Sanitation* v. *Vaccination*, p. 193.

infantile and adult." In the years 1868–71 the percentage of vaccinations to births was as high as 87.7 per cent., but in respect of adults there is no excuse for Mr. Biggs's statement.

Concerning Leicester's experience of small-pox in the pandemic I find it stated in "The Vaccination Inquirer" of December, 1897, that in the three years 1871–3 the cases were 3,297 and the deaths 360. Accepting the figures, the fatality rate is only 10.9 per cent. That is a very low rate for the pandemic, and the explanation is probably to be found, at least in part, in the high infantile vaccination rate of 1868–71. If the age period 0–5 years with its exceptional liability to fatal small-pox was well protected the epidemic would belong more largely to later years of life with a lower natural rate of fatality.

It happens that from time to time in recent years [6] Dr. Millard has quoted as follows from my book, *Vaccination Vindicated*, published so long ago, alas! as 1887:

> In Leicester when its time arrives we shall not fail to see a repetition of last century experiences, and certainly there will afterwards be fewer children left to die of diarrhoea. It is to be hoped that when the catastrophe does come the Government will see that its teachings are duly studied and recorded.

As I am by way of summing up my views on the whole subject, the opportunity may be taken of commenting on the prophecy, and generally on the doings of Leicester in respect of small-pox and vaccination.

I have learned, I hope, many things in thirty years, and feel no need to maintain now all I believed then, but the prophecy above quoted was conditional. In the same paragraph I wrote:

> Throughout the country there has been nothing approaching an epidemic since 1870–73, and Leicester has had little chance of getting its "immunity" tested. When another great outbreak occurs among the susceptible population of England it will be time enough then to see how Leicester comports itself under the ordeal.

In 1893 (in Stevenson and Murphy's *Hygiene*) I repeated the reservation that "since the Leicester experiment was begun it has not been subject to the test of any general epidemic like that of 1870–73." That reservation remains.

Nothing comparable to the great epidemic of 1870–73 has since occurred, and Leicester's immunity has not been subjected to the stipulated test. But Dr. Millard does not give the full quotation, and in *The Vaccination Question* he definitely excises my reference to the 1870–73 epidemic. Yet in proportion to the prevalence of small-pox in Britain, or in London, Leicester stood worse in 1892–93 and in 1903–4 than it did in 1870–73. But I attach little importance to these comparisons. The essential facts are (1) that small-pox is not now, in respect of fatality or infectivity or prevalence, the same virulent disease as it had been when I wrote *Vaccination Vindicated;* (2) that glycerinated calf lymph was not then available as it is now for emergency vaccination to any required extent in Leicester or anywhere else, and (3) that the Leicester Method as expounded by its protagonists a quarter of a century ago differs in important respects from the method now followed in that town. Taking as its expositor Mr. J. T. Biggs, of whom Dr. Millard specially refers, the method as it existed, or rather as it professed to exist then, is very different from that practised now.

Several points may be noted:

(*a*) The Method was "*without recourse to vaccination.*" (The italics are by Mr. Biggs.)

(*b*) The Method was entirely voluntary; there was no compulsion.

(*c*) The same hospital was used for small-pox and all other infectious diseases at the same time.*

(*d*) The same hospital was also used for the (voluntary) quarantining of contacts.

(*e*) Compensation for loss of time (of contacts) was not offered.

The best feature has been that from the beginning contacts seem to have been searched for carefully and kept under surveillance. That is an important fact, creditable to the medical officers concerned. Houses and their contents were, of course, disinfected.

* Also, Mr. Biggs wrote, "We have one horse and one ambulance van which is kept for other diseases, whether there is any small-pox or not" (*Vaccination Inquirer*, July 1st, 1891).

Every one of the items (*a*) to (*e*) has been given up.

(*a*) "Without recourse to vaccination." In saying that this item has been given up a reservation is necessary. I do not believe, and never have believed, that the Method ever was without recourse to vaccination, and that which never existed cannot be given up. But Mr. Biggs says so with the emphasis of italics. He repeats the statement, and before the Royal Commission he says, "We have dealt with small-pox without vaccination" (Q. 15374), and he speaks of "the abandonment of vaccination." Dr. Millard uses the same phrase, "abandonment of vaccination." He writes that "Leicester, indeed, by abandoning vaccination, has performed a 'control' experiment of some value,"[7] and refers to the epidemics which have occurred "since vaccination has been abandoned" (*Public Health*, Lond., 1904, xvi, 627). But there is an important difference. As he observes, "It is well to define our terms." When he says "vaccination was abandoned," he means "infantile vaccination as established by law in this country." It is in this way, by this special meaning for the word vaccination in this special connexion, that Dr. Millard is able to say that Leicester has abandoned vaccination. He states the position rather differently again when he says that the method "professes to suffice for the control of small-pox without resort to universal vaccination." Referring to the vaccination census already mentioned, Dr. Millard stated in 1904 "that thirty-five per cent. were unvaccinated, chiefly children and young adults." This was the position twenty years after what Mr. Biggs and Dr. Millard speak of as the "abandonment" of vaccination. In his report for 1902 he wrote that "all three medical officers of health who have carried out the 'system' have been firm believers in vaccination and have not hesitated to make as full use of it as possible, short of compulsion, when the occasion for it has occurred." Therefore, when Dr. Millard speaks of abandonment of vaccination he does not really mean abandonment of vaccination. But if the chairman of the Sanitary Committee of Leicester (Alderman Windley, who has filled that

office for forty years) was within even measurable distance of being correct in saying in 1887[8] that "only in a very rare instance was it (vaccination) done with consent of individuals by the ex-officer of health, Dr. Johnson, and that is so long since that he does not remember it," then there has been a vastly increased resort to vaccination, and the Leicester Method is not now in respect of vaccination what it was thirty years ago. In 1903 there were 1,084 contacts, and Dr. Millard induced nearly 800 of them living in infected houses to submit to vaccination.

The Leicester Method, in short, is *not* "without recourse to vaccination."

(*b*) Mr. Biggs declared before the epidemic of 1892–93:

> We find small-pox very easy to deal with, and the same hospital and staff of officials deal with small-pox as with other infectious diseases. There is no compulsion. If people choose, they may go into quarantine, or they may stay out. No one's liberty is infringed.[9]

There is nothing to show that removal to hospital is now any more optional in Leicester than in any other large town which possesses sufficient accommodation. That "no one's liberty is infringed" is only true if every case that is removed goes willingly—and it is unbelievable that Dr. Millard lets any patient fit for removal remain at home if the public is thereby endangered.

(*c*) The use of the same hospital for small-pox and all other infectious diseases was abandoned so early as before the end of 1892—that is, whenever small-pox became epidemic in the town, and less than two years after such use had been described as part of the Leicester Method. Not only was a separate small-pox hospital of sixty beds subsequently provided, but the whole of the ordinary hospital for infectious diseases was most prudently emptied of all other diseases and set apart for small-pox in the epidemic of 1903–4—the second since 1871–2—and Dr. Millard being now medical officer of health. It was a wise precaution, but it was not the Leicester Method.

(*d*) The quarantining of contacts at the hospital was abandoned in 1893, again when the town had to deal, not with a theory, but with a reality.[10] Dr. Sidney Coupland

says, in reporting to the Royal Commission (Appendix VI, p. 3): "It is not, therefore, to be wondered at that the sanitary authority was led to abandon this essential feature of the plan known as the 'Leicester System' and to substitute for it the generally adopted practice of maintaining infected families under supervision in their houses during the 'quarantine period' of sixteen days."

(*e*) With regard to compensation for loss of time not being offered to contacts, when such compensation was recommended by the Royal Commission on Vaccination, Dr. Millard declared that "it marks the approval of the Royal Commission of one of the special features of the "Leicester Method.'" I would not myself have regarded (*e*) as of first-class importance, but as Dr. Millard holds it to be a "special feature" it is only fair to include it in the list. Mr. Biggs said to the Royal Commission:

> I think there is sufficient evidence to prove that no compensation has been made in the shape of wages, and that all that has been done in carrying out our system has been to reimburse those whose articles of furniture have been destroyed.

The Leicester Method has in this respect, therefore, been reversed, and the reversed practice is now boldly claimed by Dr. Millard as distinctive of the Method.

Indeed, it is not vaccination but the Leicester Method in most of its features which has been abandoned in Leicester. At the same time, small-pox has in the present day become in this country a less fatal, a less infectious, and a less prevalent disease than when the Method was propounded. Under these circumstances Leicester had only 355 cases of small-pox in the epidemic of 1892–93 and 715 in 1903–4, and thus furnishes useful illustrations of the fact that, with the mild type of small-pox which prevailed in the provinces in these two epidemics, the modern method, which had taken the place of the Leicester Method, can achieve some measure of success even in a town where there is a large unvaccinated population, and where pressure towards recent vaccination is applied only to contacts.

Leicester's "Luck."—In 1904[11] Dr. Millard appreciated how much Leicester owed to the attenuated strain of virus with which it had been infected. "I fully realize," he says, "that the results of the experiment in the future may be very different from those achieved in the past. Moreover, it may have been merely a lucky coincidence that the two epidemics which have occurred since vaccination has been abandoned* have been of such an exceptionally mild type. The epidemic at Gloucester was far more fatal." But Leicester has shared in the unparalleled freedom from small-pox which this country has enjoyed since 1904, and now Dr. Millard derides the "luck" theory on which he would have been able to fall back had a severe type of small-pox with high infectivity been experienced in Leicester. In 1914 he writes:[12] "Many people appear to think that, owing to some extraordinary good luck, small-pox has never come to Leicester in a fatal or epidemic form since vaccination was abandoned."* Again: "Hitherto it had often been alleged that the 'Leicester Method' had never been adequately tested, and that Leicester had been lucky."[13] Thus in 1914 Dr. Millard ignores the reservation which he had made ten years earlier as to luck. He did not know, and none of us knew, otherwise we would have been prophesying smooth things, that the mild small-pox which first unequivocally showed itself in the epidemic of 1892–95 was the beginning of an experience which was to last and develop up till the present time. But he need not now jeer at himself, under the pseudonym of "Many people," for having prudently provided, lest the position should prove untenable, the bridge of retiral which he had builded under the name of Luck.

In one important respect, however, Leicester has been lucky. It is impossible to read the reports of Dr. Priestley on the epidemic of 1892–93 and Dr. Millard on that of 1903–4, without being impressed by the admirable skill and activity and vigilance which distinguished their management and control of the outbreaks. A public

* Dr. Millard does not mean that vaccination was abandoned. His special definition of the term vaccination has to be borne in mind.

official has no easy task in carrying out measures which are contrary to the prejudices or opinions of the authority which he serves, and it requires both tact and courage to deal successfully with so difficult a position. There is abundant evidence that in Leicester the officers have been well endowed in both respects. This has constituted Leicester's Luck.

What of the Future?

More than a quarter of a century ago I wrote that "it will not do to assume that throughout the world, from now till the end of time, small-pox will continue to rage epidemically unless prevented by universal vaccination. Just as leprosy has died out from this country and is even now dying out from Norway and Sweden and Iceland, so may small-pox or scarlatina, or measles, or any and every zymotic disease, die out in the future from this and every other land. And, quite conceivably, small-pox, rather than either scarlatina or measles, might be the next in order of the maladies to disappear from the civilized world."[14] But, I went on to argue, epidemics had been too recent and too severe to justify any assumption of such disappearance. During the quarter of a century since these words were penned, the position has vastly improved, but even yet one dare not assume that danger has departed or become negligible.

The European war has passed and the armies are returning to their own countries. It was under these circumstances that the small-pox pandemic of the early Seventies developed. Up till now no such sequel has arisen. But in considering the after-war possibilities of reintroducing small-pox into this country, there is a substantial risk of importation by persons arriving during the incubation period, especially from countries like Russia or Poland when communication with them is again opened up. As before noted, ordinary traffic carrying passengers and cargo from the North Sea and the Baltic has already begun.

It has, however, to be borne in mind that the belligerent armies have very extensively received the protection of

revaccination. What the details are for each army we do not know, and we have not yet the particulars even for the British Forces, but I would venture to hope that the amount of vaccination against small-pox in the British army must have greatly increased the total anti-variolous protection of the United Kingdom as a whole and especially of the adult male part of the population. Always in the past since the vaccination laws were enacted the child population has most benefited by legislation, and the transference of small-pox prevalence and mortality from earlier to later periods of life has been one of the phenomena most characteristic of the Jennerian prophylaxis. Now, however, infantile vaccination is largely fallen into disuse, whilst the male adult population is probably better protected than ever before. For though revaccination was always obligatory in the army, yet until this war began the army was so small as to count for comparatively little in the country as a whole. As years pass it will be interesting to watch the course of small-pox prevalence under these conditions, that is, if small-pox does resume its prevalence. Still better will it be if the disease in its old form finally succumbs to the mild strain which is now so common.

Wars have been followed by various pestilences amongst the civil population. As recorded by Dr. Prinzing,[15] bubonic plague, typhus fever, dysentery, typhoid fever, and small-pox have been concomitants of great world struggles. The virulent pandemic of influenza has so far been the only outstanding accompaniment of the greatest of all wars, though in Germany, as already noted, the enormous number of Russian prisoners introduced the infection of small-pox, which obtained more hold than that country has ever experienced since it adopted its great system of vaccinal protection. It is too soon yet to prophesy that we have seen the last consequences of the European war in respect of epidemic disease. If, however, small-pox were to invade this country, the measures at our disposal and our preventive equipment generally should enable us to deal with it, despite the fact that, on

the whole, we are going back on, rather than developing, our position in regard to general protection obtained beforehand. If the disease is of the mild or American type with low infectivity, it is all the less to be feared. If, on the other hand, the old European type of the Seventies should begin to develop, the means for meeting it are at hand. If vaccination of contacts, supplemented by isolation, disinfection, and the other measures for controlling epidemics were to prove insufficient, then I have no doubt that the spread of infection would result in the general adoption of the one solitary measure capable of controlling an extensive epidemic. That measure is vaccination, but it will be all the greater triumph of vaccination if even a limited resort to it under the modern method suffices to prevent any outbreak from assuming epidemic or pandemic proportions. Just as Lister's antiseptic system finds its greatest triumph in the aseptic system which evolved from it, in the same way success of the modern method of small-pox control will be the greatest triumph of the Jennerian prophylaxis.

In concluding these lectures, let me express my thanks to medical officers of health in various parts of the country who have kindly replied to many inquiries; to Dr. John Brownlee, of the Medical Research Committee, I am greatly indebted for aid in abstracting particulars from published reports; and to Dr. G. S. Buchanan for information as to statistics issued by the English Local Government Board. Finally, I have again to thank the Royal College of Physicians for honouring me with the Milroy Lectureship for 1919.

REFERENCES.

[1] *Public Health*, Lond., 1917, xxx, 116; and similarly elsewhere. [2] *Medical Times and Gazette*, Lond., 1868, i, 5, 32. [3] *Trans. Epidem. Soc.*, 1896–97. [4] Vaccination Tract No. 12. [5] *Glasgow Medical Journal*, 1911, lxxvi, 99. [6] *Public Health*, Lond., 1904, xvi, 609; *The Vaccination Question*, 1914, p. 101; *Public Health*, Lond., 1917, xxx, 115. [7] *Public Health*, July, 1904; *The Vaccination Question*, 1914, p. 44. [8] *Vaccination Inquirer*, November, 1892, p. 128. [9] *Vaccination Inquirer*, May, 1891. [10] Dr. Priestley's Report, p. 97, and Royal Commission's Final Report, par. 483. [11] *Public Health*, 1904, p. 627. [12] *The Vaccination Question*, p. 102. [13] Ibid., p. 137. [14] Stevenson and Murphy's *Hygiene*, vol. ii, 385. [15] *Epidemics Resulting from Wars*, Oxford Clarendon Press, 1916.

APPENDIX.

THE following article by Dr. Millard is reprinted from the BRITISH MEDICAL JOURNAL of April 19th, 1919. It relates to the Lectures as published in the JOURNAL on March 15th, 22nd, 29th and April 5th.* Dr. Millard's article was briefly commented on by me in a letter in the JOURNAL on April 26th as also reprinted below.

SMALL-POX AND VACCINATION.

A REPLY TO DR. MCVAIL.

BY

C. KILLICK MILLARD, M.D., D.Sc.,

MEDICAL OFFICER OF HEALTH FOR LEICESTER.

THERE has been so little small-pox in this country in recent years that many medical men take but little interest in it, especially those of the younger generation, of whom not a few have never even seen a case. This fact makes the Milroy Lectures on "Half a Century of Small-pox and Vaccination," by Dr. J. C. McVail, one of our greatest living authorities, all the more welcome. There are certain points, however, raised by Dr. McVail, more especially where he refers to Leicester's experience and the question whether infant vaccination is still necessary, which are of such great and far-reaching importance that I beg leave to be allowed to deal with them.

In his first lecture Dr. McVail gave some very striking figures showing the truly remarkable reduction which has

* The paragraph beginning on p. 71, and the first paragraph on p. 72, have been added to the lectures as now published.

taken place in the mortality from small-pox. Thus, in successive decades the deaths have been:

1867–76	58,614
1877–86	18,026
1887–96	4,892
1897–1906	4,763
1907–16	139

Dr. McVail sums up as follows:

> During the last half-century there has been . . . a great diminution in the fatality and in the infectivity and the prevalence of small-pox. This diminution has progressed at an increasing rate of speed. In the latter part of the half-century . . . the country has shown an unparalleled freedom from the disease. . . .

I rather gather that Dr. McVail is coming to think it probable that small-pox, following the precedent of certain other diseases, is dying out so far as this country is concerned, and with that view I entirely concur.

I note with interest that Dr. McVail does not suggest that this is due to the practice of infant vaccination, and, in view of the fact that infant vaccination is being more and more neglected, such a thesis would now be very difficult to sustain. Yet in Dr. McVail's classical work, *Vaccination Vindicated*, published in 1887, he made use of the following table, taken from the Registrar-General, showing the small-pox mortality per million in successive periods, the object being to show that with the progressive efficiency of infant vaccination, small-pox had progressively diminished:

	Small-pox Mortality, all Ages.
(1) Vaccination optional (1847–53)	305
(2) Vaccination obligatory but not efficiently enforced (1854–71)	223
(3) Vaccination obligatory and more efficiently enforced by vaccination officers (1872–80)	156

Dr. McVail quoted with approval the Registrar-General's commentary on this table:

> The figures show conclusively that coincidently with the gradual extension of the practice of vaccination there has been . . . a gradual and notable decline in the mortality from small-pox at all ages.

And again:

> The hypothesis that would explain the great fall in small-pox mortality by referring it, not to vaccination, but to general sanitary progress, must be rejected as utterly untenable.

If it could have been foreseen that at a later period a still more marked diminution in small-pox would have coincided with a greatly decreased efficiency of infant vaccination, the whole effectiveness of the table would have been completely destroyed. Yet at the time this table did seem most convincing; and I well remember in my early days making a lantern slide of it in order to illustrate an orthodox pro-vaccination lecture. From the propaganda point of view it was most "telling."

Dr. McVail has a good deal to say, favourable and unfavourable, about Leicester. He refers to the famous prophecy he made thirty-two years ago in *Vaccination Vindicated*, shortly after the town had decided to set the vaccination laws at defiance and to abandon infant vaccination. In that prophecy he not only foretold a repetition of seventeenth century experiences, *when the time arrived*, but called upon the Government to study and record the "catastrophe." How completely that prophecy was mistaken Dr. McVail now, of course, admits. Small-pox has been repeatedly introduced into Leicester, sometimes in virulent form (in one outbreak there were 5 deaths out of 16 cases), and there have been three major epidemics; yet a reference to the figures given in Dr. McVail's first lecture will show how favourably Leicester compares with most other large towns, in spite of the fact that some 90 per cent. of the children born are not vaccinated. In one of the epidemics no less than 157 cases occurred in the short space of four weeks, scattered all over the town in 103 different streets. Dr. McVail says that we have never had a really infectious type of small-pox to deal with in Leicester. Surely that was a sufficiently severe test! Yet the outbreak was quickly got under control, and subsided almost as quickly as it arose. Again, in the peroration at the end of *Vaccination Vindicated* Dr. McVail wrote:

> Among medical men there is, as has been well said, no vaccination question. They know the truth . . . so that it becomes the duty of those who know the value of vaccination, who understand the danger against which it protects . . . to teach their ignorant and misinformed neighbours what is in fact the truth about vaccination . . . the truth about a duty which cannot be neglected except at the price of infinite suffering and loss of life. Again I plead for instruction of the people in the matter of vaccination . . . but not . . . by leaving helpless children to die by thousands from small-pox, as assuredly they will die if a large unvaccinated community be permitted to grow up in our midst.

Dr. McVail observes that I have quoted from *Vaccination Vindicated* on more than one occasion, and it may be asked: Why rake up thirty-year-old prophecies which we all know now have not been fulfilled? The answer is: Certainly not in order to score off Dr. McVail, for whom I have the deepest personal respect, and who, after all, was only giving eloquent utterance to views which were held and expressed by almost the whole of the medical profession at that period. I frankly admit that at one time I myself was as firmly convinced of the danger of neglecting infant vaccination as any one. My real reason for recalling these mistaken prophecies is because, had it not been for prophecies such as these, confidently made and reiterated again and again by the highest medical authorities, the successive Vaccination Acts would never have been passed. It was because the magistrates of Leicester at one time firmly believed in such prophecies, whilst "ignorant and misinformed" people did not, that 1,154 prosecutions took place in Leicester in a single year, and that many people had their goods sold or went to prison. Altogether, in Leicester, until the town rose in revolt, over £2,300 was levied in fines, mostly from poor persons, for resisting the vaccination laws which were passed on the strength of these prophecies. I say unhesitatingly that if we had known then what we know to-day—if Dr. McVail's Milroy Lectures could have been published fifty years ago instead of yesterday—I do not believe that any of those people would ever have been prosecuted or penalized. And let us not forget that on the strength of those prophecies people are still being prosecuted to-day.

In his second lecture Dr. McVail deals with my contention that infant vaccination tends to spread small-pox by "masking" the disease. He does not deny this tendency or attempt to controvert it, but suggests that it would not be fair to allow children to be exposed to the risk of small-pox merely for the sake of possibly making it easier to control the spread of the disease. My answer to this is:

1. Laws passed by the State are for the sake of the community as a whole and not for the sake of the individual. If it should be true, as I suggest it is, that the balance of advantage so far as the community is concerned is against infantile vaccination, then although a private medical attendant might be justified—if the danger of

small-pox were very real—in advising that an infant should be vaccinated (just as in the old days he might have advised inoculation, although against the interest of the community as a whole), yet certainly the State would not be justified in making infant vaccination obligatory under pains and penalties for default.

2. But I submit that the danger of an infant contracting small-pox is no longer real. It has become so remote (and this not because of infantile vaccination but because small-pox is leaving the country) that it is now a very debatable point whether the risk the infant runs from vaccination is not definitely greater than the risk from small-pox. Moreover, one of the things we have learnt about small-pox is that where modern methods of prevention are carried out it is essentially a disease of adults rather than of children. It is spread in the factory, inn, lodging-house, etc., rather than in the home or school. (I am interested to learn that Dr. McVail, like me, has never had occasion to close a school on account of small-pox.)

Dr. McVail devotes a good deal of space to criticizing the so-called "Leicester Method," but I fear it would take too long to follow him in detail. Suffice it to say that "the proof of the pudding is in the eating." Personally I am quite content to speak only of "the modern method" of dealing with small-pox, and this, whether we admit it or not, places no reliance upon infant vaccination. The old talk about infant vaccination being our "sheet anchor" is now quite out of date.

As for the future, Dr. McVail is careful to make no more prophecies. He suggests the possibility of a serious recurrence of small-pox as a sequel to the war. He admits, however, that so far—except in much-vaccinated Germany, which has special difficulties to contend with from proximity to Russia—no recurrence has taken place. He emphasizes that in one respect we are better protected by vaccination than ever before, because of the vaccination of our troops during the war, but I would point out that the vaccination of our soldiers is recent adult vaccination, and constitutes no argument whatever for infant vaccination.

It is satisfactory to find that Dr. McVail is no longer seriously alarmed for the future, even if small-pox should recur. He writes:

> If, however, small-pox were to invade this country, the measures at our disposal and our preventive equipment generally should enable us to deal with it, despite the fact that,

on the whole, we are going back on, rather than developing, our position in regard to general protection obtained beforehand. [That is, in spite of the increasing neglect of infant vaccination. —C. K. M.]

This, of course, is a very satisfactory admission, and I trust it will be noted by all members of Parliament. He makes another significant admission which I trust will also be duly noted. At the end of his second lecture he says:

> There is, however, one conceivable condition which would not only justify but demand the cessation of vaccination. If small-pox were to disappear, so also manifestly would the need for vaccination . . . if there were no need for vaccination it would have no value, and the marvellous decrease of small-pox . . . makes such a possibility, however remote still, yet apparently less remote than ever before.

I have said much the same thing in my book, *The Vaccination Question in the Light of Modern Experience*, only I go a little further, and say that as small-pox has *already* virtually disappeared so also has the need for infant vaccination. In this matter I am merely a few years ahead of Dr. McVail, that is all.

In conclusion, in order to prevent misunderstanding as to just where I stand, allow me to make my confession of faith. Vaccination, as a scientific operation for conferring complete though temporary immunity to small-pox *upon the individual*, will live for ever, and will always remain an outstanding achievement to the credit of British medical science. It will always be of the greatest service in combating outbreaks of small-pox whenever such may occur, and it robs such outbreaks of their chief terrors. But infantile vaccination as a State institution aiming at the universal vaccination of infants has been living on a reputation largely based on prophecies now proved to have been erroneous; it is already discredited by large masses of the population, and is rapidly becoming obsolete. I submit that the time is ripe for a reconsideration of the question whether it is any longer really necessary.

"HALF A CENTURY OF SMALL-POX AND VACCINATION."

SIR,—In his reply to my Milroy lectures Dr. Killick Millard (p. 82) refers to the Registrar-General's statistics of diminishing small-pox mortality between 1847 and 1880, contemporaneously with increasing infantile vaccination, and he relates how even he had quoted and relied on these statistics in a pro-vaccination lecture. His reliance was more than justified. During the period in question up to the pandemic of 1870–73 natural small-pox was becoming a more fatal disease, and was, indeed, reaching its maximum of epidemic virulence. Yet under these circumstances increase in the practice of vaccination caused a notable decline of small-pox mortality rates per million living, and the remarkable position resulted that whilst the fatality of natural small-pox was rising, mortality was falling. In more recent years small-pox had become so attenuated in type that fatality as well as mortality had marvellously decreased, and the fact that this decrease has taken place notwithstanding lessened resort to vaccination brings into all the greater prominence the change in the character of the disease. It is not to be doubted that had small-pox maintained its old infectivity and severity, vaccination would have continued to be practised on a much larger scale than at present.

I think Dr. Millard's other points are dealt with sufficiently in the lectures, and I shall not occupy space with a condensed recapitulation here, but will reprint the whole reply as an appendix to the lectures in book form, so that whoever may be interested can make comparison. But the crucial fact is the great change in small-pox in respect both of fatality and infectivity.—I am, etc.,

Edinburgh, April 21st. JOHN C. MCVAIL.

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