**A review of certain present aspects of smallpox prevention in relation particularly to the Vaccination Acts, 1867-1907.**

FOR OFFICIAL USE.



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# A review of certain present aspects of Smallpox Prevention

## in relation particularly to the Vaccination Acts, 1867-1907.

MINISTRY OF HEALTH.

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# PREFATORY NOTE BY THE CHIEF MEDICAL OFFICER.

The Right Hon. ARTHUR GREENWOOD, M.P., Minister of Health.

SIR,

I beg to present the following Memorandum, which has been prepared in the Medical Department in accordance with your instructions, on the present position regarding smallpox prevention in England and Wales in its relation to the Vaccination Acts. An endeavour has been made to summarise, briefly, the present position, which has been reviewed from time to time in my Annual Reports; to assess the different factors in the epidemiological and clinical characters of smallpox which have been experienced in recent years, learning in this respect not only from this country but from countries overseas; to record current legislation and Orders, the results and extent of vaccination, and the incidence of smallpox in this country; and to correlate this information with the findings of the Vaccination Committee presided over by Sir Humphry Rolleston, with the extension of the practice of other forms of immunisation against disease, and with the alteration in the administration of the Vaccination Acts necessitated by the passing of the Local Government Act, 1929. It will be remembered that the administration of the Vaccination Acts was transferred under that Act from the Boards of Guardians to the Local Authorities and, like other duties thus transferred, was left unamended. We must await the results of their experience of the administration of those Acts before considering the necessity or otherwise of any modifications in the working of such administration. It is hoped that the review here attempted may prove useful to them in this situation.

The Memorandum cannot, of course, comprise an exhaustive assessment of theory and practice, but I trust that it contains a sufficiently general appreciation of the situation as will facilitate the building up of a wise and reasonable policy, with equal regard to the history of the past as to the needs of the future.

I have the Honour to be, Sir,

Your obedient Servant,

GEORGE NEWMAN.

Whitehall, S.W.1.

*February*, 1931.

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I.

# THE PRESENT POSITION OF SMALLPOX IN ENGLAND AND WALES AND THE MEASURES TAKEN TO PREVENT ITS SPREAD.

## INTRODUCTION.

For the purpose of this review, and to put current questions of smallpox control into their setting, it will be useful to present the annual mortality from this disease in England and Wales since the beginning of effective registration of causes of death. Few diseases are as distinctive as fatal smallpox, and it is unlikely that in any part of this period any mere changes in medical terminology or improvement in accuracy of diagnosis have materially affected the numbers of deaths attributed to this cause.

The changes in the mortality from smallpox, thus exhibited, result from many different epidemiological factors. They show a certain periodicity sometimes considered to be "natural" to epidemics of smallpox prevalence; they represent the reactions of the population to diverse measures of control, including vaccination; and they have also depended on various social and other events and changes which need not here be discussed. Broadly regarded, this country has, at least since the great pandemic of smallpox of 1871-2, been one of those in which the prevalence of smallpox has been considered as eminently preventable, and the disease as one which, in view of its nature and of the prophylactic means which we possess, should be banished from a civilised community which is reasonably organised for the care of the public health. There has been, and in a sense there still is, ample justification for looking at smallpox in this way. The belligerent nations during the great war nearly all so regarded it, for their civil as well as for their military populations; and smallpox, far from becoming pandemic as in 1871, was almost negligible among the epidemic diseases of 1914-18 and the years that followed them. If contrast is drawn between the conditions of the present day population in England with those of the seventeenth and eighteenth centuries, no medical point of difference would be more striking than the absence of the sickness, disfigurements and deaths caused by epidemics of smallpox. On the other hand, it is only necessary to go to certain parts of the world to-day, for example India or China, to realise that epidemic smallpox, if uncontrolled, is as capable of producing these results in the twentieth century as it ever has been.

In this review it is also taken as beyond the necessity of proof that individuals exposed to smallpox infection, however intense and whatever its type, will escape attack if at the time of the exposure they have already been recently and successfully vaccinated, and

that they will in all probability escape attack, or only suffer from a very modified attack, if they can be successfully vaccinated within forty-eight hours following exposure. The term "recently"

ENGLAND AND WALES: MORTALITY FROM SMALLPOX.*

| Year. | Population. | Smallpox. | | Year. | Population. | Smallpox. | |
|---|---|---|---|---|---|---|---|
| | | Deaths. | Rate per 100,000 | | | Deaths. | Rate per 100,000 |
| 1855 | 18,829,000 | 2,469 | 13·1 | 1892 | 29,421,392 | 431 | 1·5 |
| 1856 | 19,042,412 | 2,215 | 11·6 | 1893 | 29,760,842 | 1,457 | 4·9 |
| 1857 | 19,256,516 | 3,882 | 20·2 | 1894 | 30,104,201 | 820 | 2·7 |
| 1858 | 19,471,291 | 6,414 | 32·9 | 1895 | 30,451,528 | 223 | 0·7 |
| 1859 | 19,686,701 | 3,798 | 19·3 | 1896 | 30,802,858 | 541 | 1·7 |
| 1860 | 19,902,713 | 2,713 | 13·6 | 1897 | 31,158,245 | 25 | 0·0 |
| 1861 | 20,119,314 | 1,290 | 6·4 | 1898 | 31,517,725 | 253 | 0·8 |
| 1862 | 20,371,013 | 1,579 | 7·8 | 1899 | 31,881,385 | 174 | 0·5 |
| 1863 | 20,625,855 | 5,891 | 28·6 | 1900 | 32,249,187 | 85 | 0·3 |
| 1864 | 20,883,889 | 7,624 | 36·4 | 1901 | 32,612,022 | 356 | 1·0 |
| 1865 | 21,145,151 | 6,361 | 30·1 | 1902 | 32,950,909 | 2,464 | 7·5 |
| 1866 | 21,409,684 | 2,977 | 13·9 | 1903 | 33,293,321 | 760 | 2·3 |
| 1867 | 21,677,525 | 2,467 | 11·4 | 1904 | 33,639,287 | 507 | 1·5 |
| 1868 | 21,948,713 | 1,994 | 9·1 | 1905 | 33,988,844 | 116 | 0·4 |
| 1869 | 22,223,299 | 1,482 | 6·7 | 1906 | 34,342,040 | 21 | 0·1 |
| 1870 | 22,501,316 | 2,547 | 11·3 | 1907 | 34,698,905 | 10 | 0·0 |
| 1871 | 22,788,594 | 23,062 | 101·2 | 1908 | 35,059,484 | 12 | 0·0 |
| 1872 | 23,096,495 | 19,022 | 82·1 | 1909 | 35,423,805 | 21 | 0·0 |
| 1873 | 23,408,556 | 2,303 | 9·8 | 1910 | 35,791,902 | 19 | 0·0 |
| 1874 | 23,724,834 | 2,084 | 8·8 | 1911 | 36,189,685 | 23 | 0·0 |
| 1875 | 24,045,385 | 849 | 3·5 | 1912 | 36,382,456 | 9 | 0·0 |
| 1876 | 24,370,267 | 2,408 | 9·9 | 1913 | 36,606,226 | 10 | 0·0 |
| 1877 | 24,699,539 | 4,278 | 17·3 | 1914 | 36,960,684 | 4 | 0·0 |
| 1878 | 25,033,259 | 1,856 | 7·4 | 1915 | 35,358,896 | 13 | 0·0 |
| 1879 | 25,371,489 | 536 | 2·1 | 1916 | 34,500,000 | 16 | 0·0 |
| 1880 | 25,714,288 | 648 | 2·5 | 1917 | 33,711,000 | 3 | 0·0 |
| 1881 | 26,046,142 | 3,098 | 11·9 | 1918 | 33,474,700 | 2 | 0·0 |
| 1882 | 26,334,942 | 1,317 | 5·0 | 1919 | 36,800,000 | 24 | 0·1 |
| 1883 | 26,626,949 | 957 | 3·6 | 1920 | 37,609,600 | 30 | 0·1 |
| 1884 | 26,922,192 | 2,234 | 8·2 | 1921 | 37,885,242 | 5 | 0·0 |
| 1885 | 27,220,706 | 2,827 | 10·3 | 1922 | 38,158,000 | 27 | 0·1 |
| 1886 | 27,522,532 | 275 | 1·1 | 1923 | 38,403,000 | 7 | 0·0 |
| 1887 | 27,827,706 | 506 | 1·9 | 1924 | 38,746,000 | 13 | 0·0 |
| 1888 | 28,136,258 | 1,026 | 3·7 | 1925 | 38,890,000 | 9 | 0·0 |
| 1889 | 28,448,239 | 23 | 0·1 | 1926 | 39,067,000 | 18 | 0·0 |
| 1890 | 28,763,673 | 16 | 0·0 | 1927 | 39,290,000 | 47 | 0·1 |
| 1891 | 29,085,819 | 49 | 0·2 | 1928 | 39,482,000 | 53 | 0·1 |
| | | | | 1929 | 39,607,000 | 39 | 0·1 |

* This is an extract brought up to date from the table which appeared in the Ministry of Health Report on Public Health and Medical Subjects No. 8.

as here used cannot be very strictly defined, as rare cases have happened in which smallpox has occurred within two or three years of an apparently normal successful vaccination. But for practical working purposes successful vaccination will keep an individual safe from attack from five to ten years or perhaps even longer, and, should he nevertheless take smallpox, the disease will be very appreciably mitigated in severity. The duration of the protection conferred by vaccination against death from smallpox is very much longer than that of its protection against attack; it may indeed never wholly be lost throughout a normal lifetime.

This well-established experience is acted upon daily throughout the world in dealing with smallpox. In the countries of the East where it is habitual for the European population to be well vaccinated and to renew their protection every few years, smallpox may be said to be the one disease of which they have no apprehension, even though their ordinary occupations must lead them to frequent exposure to smallpox infection. The experience of hospitals where smallpox is treated is uniformly in the same direction. Taking for example the following periods when smallpox was epidemic in London, the table below shows the number of persons then employed in the Smallpox Hospitals and the number contracting smallpox. The latter totalled no more than 15, and for each of these there was a special explanation regarding the omission or failure of their vaccination. The numbers in the third column of the table include doctors and nurses, whose contact with smallpox was of the closest kind. No suggestion of "salting," or explanation other than the protection conferred by vaccination, is valid in these cases.

METROPOLITAN ASYLUMS BOARD SMALLPOX HOSPITALS.

| Year. | Number of smallpox cases admitted to the hospitals during the year. | Number of persons employed at the hospitals. | Number contracting smallpox. |
|---|---|---|---|
| 1892 | 348 | 158 | 2 |
| 1893 | 2,494 | 465 | 11 |
| 1894 | 1,237 | 364 | — |
| 1895 | 1,022 | 354 | — |
| 1896 | 231 | 303 | — |
| 1900 | 85 | 163 | — |
| 1901 | 1,850 | 480 | 1 |
| 1902 | 8,524 | 1,101 | 1 |
| 1903 | 435 | 473 | — |
| 1904 | 513 | 719 | — |
| 1928 | 339 | 328 | — |
| 1929 | 2,891 | 298 | — |

An example from outside London may be added. On applying at random to seven provincial smallpox hospitals for their experience of the last ten years, a total was obtained of 514 persons concerned with the nursing and treatment of 15,500 smallpox cases. Of these only two contracted smallpox, and a like explanation is forthcoming in respect of each of them.

The above are merely given as reminders, and as the smallest fraction of evidence so well established that it necessarily supplies the basis of the preventive action which responsible medical officers all over the world take and advise whenever they are confronted with the occurrence of smallpox.

But when this has been said, there remains, on the one hand, the consideration that in England (where infant vaccination has fallen to about 40 per cent. of births) and in the last few years particularly certain risks of vaccination, though remote, have come into prominence; on the other, it has been manifest that smallpox has, notwithstanding preventive efforts, become prevalent in various parts of the country, including London, and that it is showing itself, if not as a relatively trivial disease, at least as one that hardly ever has a fatal result, leaves very little disfigurement, and has few complications. Smallpox has been a disease compulsorily notifiable to all local authorities since 1899, and from 1911 onwards the total notified cases in the whole country were as follows :—

ENGLAND AND WALES : SMALLPOX.

| Year. | | No. of cases notified. | Deaths. | Fatality per 1,000 cases. |
|---|---|---|---|---|
| | 1911 | 295 | 23 | 77·97 |
| | 1912 | 123 | 9 | 73·17 |
| | 1913 | 115 | 10 | 86·96 |
| | 1914 | 64 | 4 | 62·50 |
| | 1915 | 90 | 13 | 144·44 |
| | 1916 | 149 | 16 | 107·38 |
| | 1917 | 7 | 3 | 428·57 |
| | 1918 | 63 | 2 | 31·75 |
| | 1919 | 294 | 24 | 81·63 |
| | 1920 | 263 | 30 | 114·07 |
| | 1921 | 315 | 5 | 15·87 |
| Years of Variola Minor. | 1922 | 973 | 27 | 27·75 |
| | 1923 | 2,485 | 7 | 2·82 |
| | 1924 | 3,765 | 13 | 3·45 |
| | 1925 | 5,365 | 9 | 1·68 |
| | 1926 | 10,146 | 18 | 1·77 |
| | 1927 | 14,767 | 47 | 3·18 |
| | 1928 | 12,420 | 53 | 4·27 |
| | 1929 | 10,967 | 39 | 3·56 |
| | 1930 | 9,010* | 22† | 2·44 |

* Twenty-six weeks ended 28th June, 1930 } provisional figures.
† Up to 30th June, 1930.

The above table shows that since 1922 an exceptionally large number of smallpox cases have annually been reported. Since 1926 they have ranged between 10,000 and 15,000 per annum —figures which are in conspicuous contrast with the small number of notifications in each of the first 11 years in the table. Equally striking is the fact that these increases in notified cases since 1922 have been accompanied by only the most trivial fatality rate. The actual deaths annually attributed to smallpox in this recent period have ranged between 7 and 53, and even these have in many cases been attributed to "smallpox" rather by the operation of a rigid rule for classifying registered causes of death than because in fact smallpox was the operative cause of the death.*

## The Present Prevalence of Smallpox of the variety "Variola Minor," and its Significance.

The explanation of this important change is that the great bulk of the smallpox which has occurred in this country since 1923—and there were indications of it even earlier, in the years 1919 to 1922—has been of the kind termed "variola minor." This being the first mention in this review of this epidemiological variety of smallpox—a variety that must be given some distinctive name in any attempt to set out the position at which we have arrived and the administrative questions which are involved—it will be useful to state why it has been chosen, and what it signifies and does not signify.†

*Note on Terminology.*

The terms *variola major* and *minor*, used in this review, have the authority of the last decennial International Conference on the Nomenclature of Causes of Death, Paris, October, 1929. Their English equivalents, "greater smallpox" and "lesser smallpox" are clumsy, while "mild smallpox," which is often applied to variola minor, is apt to be misleading, as "mild" is equally applicable to the individual slight cases which occur in epidemics of variola major, and indeed are then extremely common in communities like our own, where many of the cases are persons whose vaccination of years before has not been able to protect them against attack, but has prevented their suffering a serious illness.

"Variola minor" applied as a diagnosis to an individual case signifies that it belongs to an epidemic or series of infections characterised by an almost insignificant mortality among the un-

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* A death certified to have been due both to smallpox and pneumonia, for example, is classified to smallpox, however slight the smallpox or severe the pneumonia.

† Since the above was written a statement in much the same sense of the meaning which should be attached to this convenient term was adopted unanimously by the Committee of the International Health Office in Paris, on the report of its Commission on Smallpox and Vaccination.

vaccinated as well as the vaccinated, and which, while presenting clinical and pathological characteristics of smallpox, only occasionally proceeds, after the rash has been established, to pustulation—with its accompanying secondary fever, and the subsequent destruction of skin tissue which leaves serious scarring and pitting.

There is practically no difficulty, here and now in England, in diagnosing a case as one of variola minor. It is the usual type of prevalent smallpox. In every one of the 64 sanitary districts in which smallpox has recently been prevalent, the diagnosis and prognosis given by the private doctor or medical officer of health in every case showing signs of smallpox is based upon, and influenced by, our knowledge and experience of this type. Here and there, on the first appearance of smallpox in an area, or in the practice of a particular doctor without knowledge of the antecedent infection, the question arises whether the symptoms and the rash are an expression of the minor or of the major variety. It is a proper and necessary question ; the case may be exceptional, and be connected with an unknown and major source. But the inquiries made by the medical officer of health (or by medical officers of the Ministry of Health) which follow the report of such a case as " smallpox " will very soon clear up the position.

In any event, so far as the notifying practitioner is concerned, the notification officially required of him does not demand any discrimination of epidemiological type : the disease he has to notify under Statute is *smallpox*, not subdivisions of it made on epidemiological grounds. In recognition of this fact, and in order to allow for particular and borderline cases which the recorder cannot put to one subdivision or another of smallpox without epidemiological information not in his possession, the International Conference provided a third sub-heading " smallpox, variety not stated," in addition to " major " and " minor." The International List of causes of death, as determined in Paris in October, 1929, thus specifies the following in its " detailed list."

I. 6. *Variola.*
   (*a*) Variola major.
   (*b*) Variola minor ; alastrim.
   (*c*) Variola, variety not stated.

The term " *alastrim*," alternative to variola minor, is widely used in some countries and, whatever may have been its original significance, it now usually signifies the same concept as variola minor. Despite the convenience of a single word however, " alastrim " has not been much used in England and has been avoided in this review. Many still consider that it cannot be used without seeming to assent to the suggestion, at one time often implied, that " alastrim " is not a smallpox at all, or they regard it as a term which invites camouflage of smallpox, or has been misused. These objections might be met by speaking, not of " alastrim" but of

"alastrim-smallpox," but the latter then becomes clumsier than "variola minor."

Referring to the table above, variola minor may have been, and no doubt was, responsible for certain of the smallpox sporadic outbreaks which made up the totals of notified cases between 1911 and 1922,* but in the main the history of these cases was that they represented small limited outbreaks of variola major, originating in imported infection. From 1923 onwards however, the prevalence has been almost entirely of the minor variety, although at intervals groups of cases of variola major have been included in circumstances pointing to the introduction of a separate and imported infection.

*Clinical Characteristics of Variola Minor.*

On account of the mildness of the smallpox prevalent in 1922, and of the lack of experience of the disease amongst the younger school of practitioners by reason of the almost complete absence of smallpox from this country for many years, errors in diagnosis were comparatively frequent. The Minister of Health appointed a Committee of experienced medical men to visit the various places where the medical profession were in doubt as to the nature of the prevailing illness. The Committee came unanimously to the conclusion that there was no reason for regarding the "doubtful" cases they had seen in which the eruption was present as other than smallpox of benign character. In the following year the clinical features of variola minor were described as follows :—†

> "The disease is usually ushered in by a sharp, sudden illness characterised by headache, pyrexia, sweating, pain in the back and limbs, and vomiting—occasionally delirium is met with. A provisional diagnosis of influenza is common. The initial symptoms may be insignificant. In some cases no history of illness can be obtained. The severity of the constitutional symptoms is no criterion of the extent of the characteristic eruption, which itself may or may not be preceded by a prodromal rash, and which in the matter, time and place of its appearance differs little from that observed in the more severe attacks. Sometimes, however, the rash appears on the extremities as much as twenty-four hours later than on the face. The evolution of the eruption, where such proceeds, is regular, and although it conforms generally to the classical type the lesions are apt to pass through their successive stages with increased rapidity (papule, vesicle, pustule, crust). On the other hand, they may abort wholly or partially in any stage. These phenomena have led to an appearance suggesting to some

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* This was the case in certain instances (Oldham 1913, Milnrow 1914) in which infection of the minor variety was believed to have been introduced by raw cotton from America.

† Annual Report of Chief Medical Officer, 1923, p. 30.

observers the "cropping" of varicella. Secondary fever is commonly absent. As a rule, convalescence is uninterrupted and the mortality is very low. The incidence of the disease is dependent on the vaccinal condition."

It has been pointed out* that this description differed little from that of a type of smallpox described by Marson in 1866,† by Adams in 1806,‡ by Jenner§ in 1798 and possibly also—although at this time there may have been some confusion with chickenpox—by Wagstaffe‖ as far back as 1722. These observers described the co-existence side by side of fatal and non-fatal types. Indeed Wagstaffe went so far as to say that "we have the sort in which a nurse cannot kill and another in which even a physician can never cure." These two types rarely co-exist to-day in this country because the fatal type when introduced is more quickly mastered. The unvaccinated then seek protection in large numbers. It is computed that within a month of the appearance of severe smallpox, in connection with the "Tuscania" incident, no fewer than 225,000 charges of lymph were issued for vaccination. This figure is equivalent to more than $\frac{2}{3}$rds of the total annual consumption of Government lymph issued for infantile vaccination.

Six years' further experience of variola minor serves only to emphasise the accuracy in the main of the description written in 1923, although some little readjustment may be made in order further to accentuate the exceptional mildness of variola minor which, save only in this particular, is identical with the smallpox of Wagstaffe, Jenner, Adams and Marson. A measure of this difference is the fact that some observers decline to recognise the condition as even akin to smallpox.

The first indication of the disease may be a papular eruption with a centrifugal distribution characteristic of variola, which may be so scanty as to be overlooked, so discrete as to lead to mistaken diagnosis, or so confluent as closely to resemble the eruption of severe variola major. Yet, whatever these manifestations, the constitutional disturbance in ordinary circumstances is relatively insignificant and the case gives rise to no anxiety. Nevertheless, it is to be remembered that we are dealing with smallpox and that, in common with all infectious disease, variola minor may be followed by degenerative changes (e.g., of the nervous system) which may lead to complications or a fatal issue.

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* Annual Report of Chief Medical Officer, 1924, pp. 39-40.

† Reynold's System of Medicine, Vol. i, p. 440.

‡ Observations on Morbid Poisons, Chronic and Acute, Joseph Adams, M.D., 1807.

§ Enquiry into Causes and Effects of the Cowpox, Edward Jenner, M.D., F.R.S.

‖ Half a Century of Smallpox and Vaccination, John C. McVail, M.D.

## Comparison with varieties of smallpox in other countries.

It is necessary here to inquire to what extent the smallpox situation in England just described has its counterpart in other countries. The outstanding epidemiological fact which emerges from a survey of the world distribution of the disease is that the strains of smallpox infection current in different countries are of different degrees of virulence or toxicity, and that these different strains breed true over a long series of years. Thus we find that there are (*a*) countries in which the prevailing strain is recognised to be of virulent type with no noticeable change from ancient times to the present day, (*b*) countries in which, at the present time, the prevailing strain is non-virulent, (*c*) countries in which a non-virulent and a virulent strain may prevail side by side, without evidence that the toxicity of either becomes enhanced or deteriorated by the association.

India and other countries of the Far East and also Northern Africa furnish notable examples in the first category. Examining any long series of smallpox mortality statistics for India, it is seen at once that the country is one in which the prevailing endemic strain of infection has maintained its virulence throughout the ages and is not less potent now than it ever was.

SMALLPOX DEATHS IN BRITISH INDIA.

| Year. | Deaths. | Year. | Deaths. | Year. | Deaths. | Year. | Deaths. |
|---|---|---|---|---|---|---|---|
| 1880 | 69,848 | 1893 | 68,894 | 1905 | 70,962 | 1917 | 62,277 |
| 1881 | 74,296 | 1894 | 44,060 | 1906 | 109,583 | 1918 | 93,076 |
| 1882 | 85,138 | 1895 | 45,733 | 1907 | 103,988 | 1919 | 136,077 |
| 1883 | 232,363 | 1896 | 141,443 | 1908 | 170,694 | 1920 | 101,329 |
| 1884 | 332,904 | 1897 | 167,318 | 1909 | 101,152 | 1921 | 40,446 |
| 1885 | 80,630 | 1898 | 62,517 | 1910 | 51,315 | 1922 | 40,836 |
| 1886 | 51,097 | 1899 | 53,347 | 1911 | 58,535 | 1923 | 44,084 |
| 1887 | 65,755 | 1900 | 91,855 | 1912 | 89,357 | 1924 | 55,380 |
| 1888 | 93,556 | 1901 | 89,378 | 1913 | 98,155 | 1925 | 85,986 |
| 1889 | 130,624 | 1902 | 115,443 | 1914 | 76,590 | 1926 | 117,066 |
| 1890 | 119,854 | 1903 | 93,693 | 1915 | 83,282 | 1927 | 51,776 |
| 1891 | 98,831 | 1904 | 55,232 | 1916 | 60,642 | 1928 | 39,981 |
| 1892 | 101,121 | | | | | | |

When this strain is carried overseas, as has happened frequently during the last half century and more, it causes the same heavy mortality as in the country of origin ; in a recent epidemic of 407 cases at Aden it was responsible for a case-mortality of nearly 43 per cent. among the unvaccinated. In April, 1929, infection was carried from Bombay to England and Scotland and caused what was described as "a very virulent form of smallpox" among the small number of unvaccinated persons to whom it had the chance of spreading.

Of countries in the second category there are examples in several parts of the world, notably the West Indies, the United States of America, Canada and South Africa. For example, the following are the official weekly figures* of smallpox incidence in the United States as a whole during March, April and May, 1930 :—

| Week ending | Cases in 46 States. | Deaths. |
|---|---|---|
| 8th March ... ... ... ... | 1,822 | 0 (90 Cities) |
| 15th ,, ... ... ... ... | 1,549 | 0 (89 ,, ) |
| 22nd ,, ... ... ... ... | 1,429 | 0 (91 ,, ) |
| 29th ,, ... ... ... ... | 1,644 | 0 (90 ,, ) |
| 5th April ... ... ... ... | 1,673 | 0 (88 ,, ) |
| 12th ,, ... ... ... ... | 1,601 | 1 (87 ,, ) |
| 19th ,, ... ... ... ... | 1,485 | 0 (90 ,, ) |
| 26th ,, ... ... ... ... | 1,583 | 0 (90 ,, ) |
| 3rd May ... ... ... ... | 1,393 | 0 (88 ,, ) |
| 10th ,, ... ... ... ... | 1,259 | 2 (91 ,, ) |
| 17th ,, ... ... ... ... | 1,302 | 0 (89 ,, ) |
| 24th ,, ... ... ... ... | 1,087 | 0 (90 ,, ) |
| 31st ,, ... ... ... ... | 758 | 0 (89 ,, ) |

The persistence of this non-virulent type year by year in particular cities is exemplified in the following statistics :—

| — | Portland (Oregon) (Population 207,214). | | Spokane (Washington) (Population 109,000). | | Atlanta (Georgia) (Population 255,000). | |
|---|---|---|---|---|---|---|
| Year. | Cases. | Deaths. | Cases. | Deaths. | Cases. | Deaths. |
| 1920 | 1,458 | 2 | 1,156 | 1 | 284 | — |
| 1921 | 561 | 1 | 955 | 1 | 653 | 3 |
| 1922 | 833 | 1 | 286 | — | 67 | — |
| 1923 | 375 | — | 434 | 1 | 541 | — |
| 1924 | 413 | — | 481 | — | 1,595 | 6 |
| 1925 | 303 | — | 59 | — | 33 | — |
| 1926 | 332 | — | 27 | — | 111 | — |
| 1927 | 236 | — | 445 | — | 314 | 1 |
| 1928 | 1,051 | 3 | 332 | — | 40 | — |

In April, 1913, this strain was carried overseas to New Zealand and Australia and caused in both countries an epidemic of the same mild type. In Australia the epidemic began among the employees of a clothing factory at Sydney, the appearance of the rash or eruption (described by those affected as " pimples " or " small boils ") being preceded by an attack of so-called " influenza " with headache, vertigo, shivering and general pains. The origin was traced to con-

* Figures taken from U.S.A. Public Health Reports.

tact with a ship's steward who had the same kind of rash on his arrival at Sydney on a ship from Vancouver. The epidemic spread widely but with low infectivity in the State of New South Wales; by the end of the year 1,073 cases had been notified. It continued, but with a declining incidence, until the end of 1917. The total number of notifications was 2,400 with four fatal cases, of which, however, only one was considered to be a case in which smallpox was more than a contributory cause of the death. In New Zealand the first case was a missionary from Utah who had joined the ship at Vancouver and landed at Auckland on 8th April, 1913. The disease spread in the family with whom he stayed and from them to the Maoris and white population in the North Island. It persisted until April, 1914, by which time it was estimated that 114 Europeans had been attacked, with no death, and 1,778 Maoris, with 55 deaths.

Examples of countries in the third category, in which there is persistence side by side of a non-virulent and a virulent strain, are England, Brazil (where the recognition of the existence of two separate strains, one causing a high mortality, the other almost none, dates from 1910) and some of the Southern States of North America, which, already affected with the prevalent benign type, are also liable to frequent importation of the virulent type prevailing in Mexico. Among 6,369 cases of smallpox notified in some of these States between 1915 and 1928 there were 1,509 deaths, a case-fatality of 23·7 per cent., as compared with the case-fatality figure of 0·13 per cent. calculated for other States in which only the non-virulent type prevails. Sometimes in the United States, as in England, it has been possible to trace the carrier of an imported virulent strain of infection and all the resulting cases, thus bringing to light the remarkable difference of toxicity between the foreign and the local endemic strain. At Detroit, for example, where between 1915 and 1923 the benign type was endemic (4,631 cases with only 17 deaths) the importation of a virulent case in January, 1924, was the cause of 163 deaths before the epidemic was got under control by the vaccination of over half a million people within a month. Similar epidemics due to importation from Mexico caused 17 deaths among 119 cases at Los Angeles in 1912, 49 deaths among 191 cases at El Paso (Texas) in 1914, and 20 deaths among 59 cases at Washington in 1925.

In considering smallpox epidemics in terms of case fatalities, it must be remembered that often many cases with a considerable degree of vaccinal protection have been included in the totals on which the deaths are calculated. True contrasts of case fatality for this purpose ought to be limited to unvaccinated cases and unvaccinated deaths, but these are rarely separately obtainable for statistical purposes. The combined figures, however, suffice to bring out the difference. An example is the occurrence of variola minor in Switzerland between 1921 and 1926, which closely resembled the present variola minor in England.

SWITZERLAND.

| Year. | | Cases. | Deaths. |
|---|---|---|---|
| | 1909 | 21 | 3 |
| | 1910 | 28 | 2 |
| | 1911 | 92 | 11 |
| | 1912 | 21 | 3 |
| | 1913 | 23 | 0 |
| | 1914 | 19 | 0 |
| | 1915 | 4 | 2 |
| | 1916 | 3 | 0 |
| | 1917 | 0 | 0 |
| | 1918 | 2 | 0 |
| | 1919 | 3 | 0 |
| | 1920 | 2 | 0 |
| Variola Minor. | 1921 | 596 | 7 |
| | 1922 | 1,153 | 3 |
| | 1923 | 2,126 | 2 |
| | 1924 | 1,234 | 2 |
| | 1925 | 329 | 1 |
| | 1926 | 54 | 1 |
| | 1927 | 0 | 0 |
| | 1928 | 1 | 0 |
| | 1929 | 0 | 0 |

Returning now to the English endemic smallpox of the last seven or eight years, the justification for giving it the sub-classification of variola minor lies in the facts of its clinical character and low fatality rate, and that unvaccinated persons affected have almost wholly escaped the serious illness, disfigurement, and death with which they are so selectively smitten in the course of an epidemic of variola major. Those in this country who have long habitually dealt with and thought of smallpox in terms of variola major (with "mild smallpox" as a mere incident, or something only characterising those insufficiently vaccinated), and who realise also that infection of the same nature may at any time accidentally be imported from abroad in the same way as formerly, have been slow, and rightly slow, to accept the evidence that the prevalent endemic smallpox is a variola minor definitely stabilised at low virulence and low infectivity. Acceptance involves recasting, restating and qualifying a large number of statements and views regarding smallpox which have hitherto been based on the experience of variola major alone. This applies in particular to the serious forecast which it has been customary, and necessary, to give on learning that an unvaccinated infant has been attacked by smallpox, or that a number of cases of smallpox have occurred undetected in a school where the children are unvaccinated. It has to be recognised that these tragedies, as they would be in the case of the major disease, have not occurred with the minor. In this respect the present English experience is merely

a repetition of what has been shown to have happened with variola minor, on a large scale and as a result of many years' experience, in other parts of the world, notably the United States, Australia and Switzerland. Nor was there any clear and indisputable evidence of the minor variety ever becoming the major, an important indication of stability.

## Administrative Control against both Varieties of Smallpox.

Both variola major and variola minor are in fact "smallpox" and it is as "smallpox" that they are notified by medical practitioners and dealt with by medical officers of health and public health authorities.

Public Health Authorities in this country, working always on experience of variola major and its well-known characteristics, have practically from their first existence in 1848 been concerned in preventing the spread of smallpox and with the isolation and treatment of smallpox cases. The preventive measures to be taken are ordinarily considered straightforward and efficacious, so that if applied on the first appearance of smallpox in a locality the outbreak can be speedily terminated. If the epidemic has become diffused and has been allowed to increase in an area for a number of weeks, it may for a time reach considerable proportions and call for a large amount of effort and expenditure before its extinction. Nevertheless its extinction is only a matter of time with the means at the disposal of a medical officer of health and a reasonably equipped public health department. The diminution of smallpox towards the end of last century, as illustrated by the mortality shown in the Table on page 6, coincided with great advances in the organisation of local authorities in dealing with infectious diseases, and so not only with the development of public health administration, but with the general practice of providing infectious diseases hospitals. Among these the isolation of smallpox patients has always received special attention, the more so since it was conclusively shown between 1881 and 1886 that the isolation of a number of cases of acute smallpox in hospitals situated within populous areas habitually produced an excessive amount of smallpox in the vicinity of the hospital.

Consequent on this demonstration it has for many years been the practice to keep in readiness, for the isolation of smallpox, hospitals which are specially earmarked for that disease and remote from aggregations of population. Since 1885 all cases of smallpox occurring in the Metropolitan area, even in epidemic years, have, with this object, been removed out of London altogether, and similar provision for this disease is made in most other places. It was the practice of the Local Government Board, and is now that of the Ministry of Health, to insist upon separate provision of smallpox isolation hospitals being made by local authorities, or alternatively to require, in cases dependent on the sanction of the Department, that hospitals when used for smallpox should not treat cases of

other diseases on the same site at the same time. No general infectious diseases hospital was, with the sanction of the Department, to be used for smallpox at all if it was situated in the middle of towns or populous areas. The need for this prescription was illustrated as recently as 1903-5 by the excessive occurrence of smallpox in various places—even in the sparsely populated neighbourhood of the hospital ships in Long Reach which then took the London smallpox cases.

Taking only those hospitals which are specially earmarked for smallpox, local authorities at present maintain 6,917 beds in 314 hospitals in this country; practically every County Borough possesses its smallpox hospital and in many cases considerable areas have been combined for the purpose of smallpox provision. With few exceptions the several English and Welsh counties are so organised that smallpox hospital accommodation is available to meet the requirements of any constituent district in which smallpox should occur.

The ordinary and practically universal preventive practice on the notification of a smallpox case, subject to any necessary confirmation of diagnosis, is to remove the patient at once to a smallpox hospital, do the necessary disinfection of the patient's belongings and the house or quarters which he has occupied, and to search for and deal with the individuals who have been in contact with him since the beginning of the illness. Fortunately smallpox is little, if at all, infectious until the end of the incubation period. The latter is as a rule fairly stable—in the region of 12 days between the exposure to infection and the appearance of first symptoms, or of 14 days until the appearance of the rash. It is consequently much more possible with smallpox than with other diseases to determine in advance when the contact will develop smallpox if he is going to do so, and when in that case he would begin to constitute a danger of infecting other people. A watch can be kept upon him when this period begins and his isolation can immediately follow any symptoms of the onset of smallpox. The persons with whom he is in association can also be safeguarded, and it is a general practice in connection with smallpox infection to compile lists of contacts in the dwelling and also to keep under observation others with whom the smallpox patient had been in habitual association, at his place of work or otherwise, before his illness began.

No part of this system of contact tracing and observation would serve its purpose if it were not for the part which vaccination plays in the preventive system. If the contact can be identified within the first day or two of exposure to infection he must be offered vaccination, and if he accepts and it "takes" then he will in all probability escape infection. And when it is established that the patient has been in association with others, for example, at his place of work or at school, the community in question should be vaccinated forthwith and practically freed from further risk, or at least every opportunity for their individual protection must be offered.

The preventive measures thus roughly sketched have in this country been the standard practice, enjoined by the Central Department and adopted by public health authorities. They were set out by the Ministry of Health in detail and with emphasis in the Memo. 71a., Med., issued in November, 1922,—"*Memorandum on the steps requisite to be taken by Sanitary Authorities on the occurrence of smallpox*," and they have a notable record of success behind them. In any of the years 1911 to 1922 for example (*vide* Table on p. 8) the figures of notified cases represented a number of foci of infection which were extinguished by these procedures. They called for effort and expense and emergency action, and if it had not been for the intrusion of variola minor about 1922 and its extension in the years which followed, there is every reason to believe that the same procedure would have continued as effective, and that smallpox in these last years would have been as rare in this country and as quickly extinguished when it appeared, as was the case from 1911 to 1922. In point of fact variola major has appeared at intervals on several occasions since 1922, following importation from overseas. A recent example which received much notice was that of the s.s. Tuscania in 1929. The normal system of prevention above described was in this case so successful that the secondary cases resulting from a very widespread imported infection were limited to six, and the virulent strain was eliminated within a few weeks of its introduction.

### Results of Control in the Case of Variola Major.

With variola major in fact there are good reasons for regarding the whole preventive system available, and constantly tested by local authorities for many years in this country, as effective. Experience had perhaps shown that the system could be improved in certain matters of detail; the M.O.H. was often put to unnecessary trouble, and the authority to needless expense, by not possessing sufficient authority to deal with smallpox contacts, while the procedures available to secure vaccination were rather unduly burdened by official requirements. Until the advent of variola minor altered the position in certain parts of the country, the chief criticism made of the system was that it was in some respects in excess of what was required by the risk. This (apart from procedure under the Vaccination Acts) applied particularly to the smallpox hospitals, and to the cost of having to provide them and keep them empty; so much was this the case that in many instances arrangements were made for their utilisation for other diseases, for example, tuberculosis, on the understanding that they would be cleared and used only for smallpox if that disease appeared.

Stimulated by the central authority, which for some years required immediate intimation by telegram or telephone of the details of every smallpox case in the country, and exercised in respect of this disease a close and detailed supervision analogous

to that applied to diseases like plague, cholera and typhus, the tradition was well established that everything had to give way to a smallpox notification. Careful tracing of contacts, aided by modern methods of communication, made it practicable to keep them under close observation and deal with secondary cases at the earliest moment before opportunity of spread of infection had arisen. The vaccination which was essential to success very rarely failed to be accepted in view of the definite exposure to risk ; if the epidemic spread, the inhabitants of the district flocked to the public vaccinators or to their own doctors, and in course of time a substantial proportion of the population became protected. This statement, it should be noted, applies even to those parts of England where habitual vaccination of infants under the Vaccination Acts has long been partly or largely in abeyance. It is as applicable to anti-vaccination Leicester and counties in the Midlands as to other parts of the country where vaccination under the Vaccination Acts has proceeded normally and there has been little use of the conscientious objection clause. The success obtained, moreover, was largely to be attributed to a combination of the efforts of the local authorities which the central Department actively encouraged—not only by promoting combinations of areas for the provision of smallpox hospitals, but also by pressing special arrangements for intercommunications between adjoining districts on all matters which might affect the extension of the outbreak. In the London area, for example, there has long been a system of intercommunication regarding individual cases and contacts between the several Borough Councils, the London County Council and the smallpox hospital authority—until April last the Metropolitan Asylums Board—which has left little to be desired in the way of completeness.

If—still speaking of variola major, and the risks of its passing the vigilance of port sanitary authorities and becoming locally epidemic—practical epidemiologists remained nervous about smallpox, their apprehensions were often referable to the recollection of two outstanding smallpox experiences in this country, its appearance in the pandemic of 1871–2, and the catastrophe of the Gloucester schools in 1895. But it is permissible, with the experience of the last war behind us and with the international understandings since established, to doubt if, with modern prophylaxis, there will be smallpox pandemics of the 1871–2 degree in future. And it is almost inconceivable that, under modern administration, the fatal Gloucester school episode could be repeated anywhere to-day. In a word, subject to consideration of the details referred to above, we have been able, almost since the beginning of the century, to think of major smallpox as a rare, exotic disease which we effectively hold in check and extinguish when it appears. We can complacently contrast our position in this respect with that of any other country in the world, and there is no reason why we should not continue to do so.

## Results of Control in the Case of Variola Minor.

Now all these preventive measures have been available, and in the majority of cases have been utilised and applied, to variola minor, since its appearance, in precisely the same way as to variola major. When variola minor has spread from the centres in which it has become established and has invaded new districts, the notification of the new case has, in instances which may be numbered by the dozen, been thus met and been followed by the speedy extinction of the disease in the new districts or perhaps even by its limitation to the single imported case. It would not perhaps be justifiable to say that these measures have invariably been the cause of this satisfactory result ; it is certain that some of it is attributable to the nature of variola minor, which, case for case, possesses a less degree of infectivity, and shows a less rapid power of local diffusion (whatever this may signify) than variola major. The fact remains, however, that the appearance of variola minor in a new district at the present day is often successfully controlled and kept to minimal proportions by applying to it all the measures applicable to the major variety. As an example of this, the following table has been prepared from the 1927 notifications, to illustrate the speedy extinction of smallpox after its first appearance in districts of different types.

| County. | Name of District. | No. of cases of smallpox notified in 1927. | Approximate duration as measured by the notifications. |
|---|---|---|---|
| Buckingham-shire | Buckingham B. .. | 4 | 3 weeks |
| | Chepping Wycombe B. | 2 | 2 ,, |
| Cheshire .. | Stockport C.B... .. | 5 | 4 ,, |
| Lancashire .. | Formby U.D. .. .. | 2 | 1 week |
| | Fulwood U.D. .. .. | 4 | 8 weeks |
| | Gt. Harwood U.D. .. | 28 | 9 ,, |
| | Haslingden B. .. .. | 3 | 2 ,, |
| | West Lancashire R.D. | 4 | 7 ,, |
| | Wigan C.B. .. .. | 34 | 8 ,, |
| Nottingham-shire | Worksop R.D. .. | 4 | 4 ,, |
| Staffordshire | Leek U.D. .. .. | 2 | 1 week |
| Yorkshire .. | Denholme U.D. .. | 2 | 1 ,, |
| | Goole U.D. .. .. | 2 | 3 weeks |
| | Gt. Driffield U.D. .. | 5 | 4 ,, |
| | Halifax C.B. .. .. | 5 | 3 ,, |
| | Hoyland Nether U.D. | 4 | 1 week |
| | Maltby U.D. .. .. | 13 | 5 weeks |
| | Morley B. .. .. | 2 | 4 ,, |
| | Pontefract R.D. .. | 4 | 7 ,, |
| | Settle R.D. .. .. | 2 | 7 ,, |
| Glamorgan-shire | Aberdare U.D. .. | 2 | 2 ,, |
| | Caerphilly U.D. .. | 4 | 5 ,, |
| | Llantrisant and Llantwit Fadre R.D. | 2 | 6 ,, |
| | Merthyr Tydfil C.B. | 2 | 3 ,, |
| | Penarth U.D. .. .. | 2 | 1 week |
| Monmouth-shire | Llantarnam U.D. .. | 2 | 5 weeks |
| | Magor R.D. .. .. | 2 | 1 week |
| | Newport C.B. .. .. | 5 | 5 weeks |

The difficulty which has arisen depends upon the fact that in a considerable and increasing number of centres in different parts of the country—and since the end of 1929 specially in parts of London—variola minor has slowly succeeded in establishing itself notwithstanding preventive measures on these lines, and that after it has become well established—not necessarily in epidemic form—its extinction by these measures has become more and more difficult and costly, if not actually impracticable. If, after a series of years of endemicity in particular regions, it shows signs of local diminution, it is by no means certain how far public health action has been responsible; the infection may have exhausted its susceptible material and extinguished itself.

In the subjoined Table there is set out the number of smallpox cases occurring in each invaded County year by year since 1919.* The order in which the Counties are set out is approximately the order of their invasion. The more populous counties of the North of England reaching as far south as Derby and Nottingham were first invaded and the disease appeared nearly simultaneously in all of them. The agricultural county of Westmorland remained free and the industrial parts of Cumberland were affected only in 1924. With these exceptions the disease has continued to prevail in this region since its introduction to the present date. There has been no corresponding prevalence across the Border in Scotland nor any in Ireland.

The table illustrates in the main an extension from the north of England towards the south, the leisureliness of which, when modern communications are taken into account, goes far to support the statement that the infective quality of variola minor, and its "diffusibility," have much lower potentialities than classic smallpox. If the 35 cases in Suffolk in 1919, the 75 in Essex in 1920 and the 1,130 in Gloucester in 1923–4 be treated as the exceptional instances they undoubtedly were, then there was practically no smallpox south of Nottinghamshire for the first five years in the table. At the end of this period Leicestershire, Northamptonshire and Warwickshire were involved, though only slightly, from 1923–5. It was not until 1927 that any considerable number of cases occurred south of the Northern Midlands, and in that year the industrial regions of South Wales were also involved. No important spread, apart from the north, took place until 1928, which in point of the number of seriously invaded counties was the year of maximum extension. In that year smallpox appeared in London, some of the Home Counties and the South Midlands, and extended also to a small extent to counties south of the Thames.

* The figures relate almost entirely to the minor variety, but include notified cases at Pontefract in 1919, in the New Forest in 1921, at Poplar in 1922, at Willesden in 1924 and 1926, at Hendon in 1927, and in a number of scattered places in 1929 (s.s. Tuscania), where the major variety was introduced. The number of cases occurring in these various places varied from half-a-dozen to 50, but in no single place did the number exceed 50, as the type was so severe that the contacts accepted vaccination almost without exception.

The figures for the Northern Counties suggest that in the invaded areas as a whole the numbers tend to increase up to a maximum in the fourth or fifth year, after which they decline. The significance of this observation from the point of view of pure epidemiology is considerable ; it suggests that in variola minor we have to deal with a type of infection that only succeeds in attacking a small proportion of a population which, by all ordinary criteria, should be highly receptive to a rapid extension. Speculations on this matter are beyond the scope of this review, but it is practically important to note that if this history is to be repeated in the case of London and the Home Counties we may look forward to several further years of smallpox prevalence from the present date. The progress of notified smallpox in London is shown in the further table giving the cases in each Metropolitan Borough since 1922. This table illustrates, on the one hand, the frequency with which, in years before 1928, smallpox was promptly extinguished after its discovery in most of the boroughs and, on the other, the extent to which it has established itself since 1928 in certain parts of the metropolis.

SMALLPOX CASES, 1919–1929. ENGLAND AND WALES.

| County. | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 | 1929 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northumberland | — | — | — | — | 10 | 401 | 711 | 843 | 682 | 507 | 235 |
| Durham ... ... | 18 | 3 | — | 3 | 37 | 20 | 1,138 | 6,645 | 6,446 | 2,564 | 812 |
| Cumberland ... | — | — | — | — | — | 186 | — | — | 1 | — | — |
| Yorkshire—N.R. | 2 | 16 | 47 | 253 | 108 | 539 | 934 | 12 | 173 | 256 | 2 |
| E.R. | — | — | — | 1 | — | 9 | 59 | 43 | 6 | 83 | 11 |
| W.R. | 13 | — | 94 | 216 | 283 | 104 | 278 | 1,270 | 3,244 | 2,310 | 1,691 |
| Lancashire ... | 43 | 113 | 4 | 62 | 88 | 106 | 40 | 139 | 442 | 939 | 564 |
| Cheshire ... ... | 15 | 16 | 15 | 1 | 1 | 34 | 24 | — | 8 | 112 | 68 |
| Derbyshire ... | 1 | — | 15 | 237 | 462 | 1,351 | 1,085 | 982 | 611 | 821 | 772 |
| Lincoln—Lindsey | 4 | — | — | 1 | 3 | 130 | 24 | 49 | 102 | 112 | 9 |
| Kesteven | — | — | 1 | — | 2 | — | 16 | — | 3 | 22 | 17 |
| Holland | — | — | — | — | — | — | 2 | — | — | 26 | 25 |
| Nottingham ... | — | 1 | 126 | 96 | 420 | 536 | 599 | 191 | 516 | 460 | 67 |
| Stafford ... ... | 2 | — | 1 | 9 | 9 | 13 | 1 | 6 | 28 | 524 | 523 |
| Leicester ... ... | — | — | 2 | — | 23 | 105 | 80 | — | 7 | 112 | 537 |
| Norfolk ... ... | 3 | — | — | — | — | — | — | — | — | 64 | 2 |
| Ely, Isle of ... | 7 | — | — | — | — | — | — | — | — | 11 | 14 |
| Peterborough, Soke of | — | — | — | — | 1 | — | 2 | — | 1 | 55 | 253 |
| Northampton ... | — | — | — | — | — | — | 210 | — | 2 | 102 | 508 |
| Warwick ... ... | — | — | — | — | 5 | 73 | 122 | — | 84 | 294 | 8 |
| Worcester ... | — | — | — | — | 1 | — | 1 | — | — | 8 | 1 |
| Suffolk ... ... | 35 | — | — | — | — | — | — | — | — | 11 | 1 |
| Cambridge ... | — | — | 1 | — | — | — | — | 1 | — | 1 | 1 |
| Bedford ... ... | — | — | — | — | — | 4 | 4 | — | — | 83 | 9 |
| Buckingham ... | 4 | — | — | — | 1 | 3 | — | — | 6 | 16 | 61 |
| Oxford ... ... | — | — | — | — | 1 | 1 | — | — | — | 4 | 2 |
| Gloucester ... | — | — | 7 | — | 985 | 145 | — | — | 22 | 63 | 17 |
| Hereford ... ... | 1 | — | — | — | 2 | — | — | — | 2 | 2 | — |
| Essex ... ... | 7 | 75 | — | 4 | 2 | — | — | — | 1 | 97 | 1,378 |
| Hertford ... ... | 8 | — | — | — | 1 | 4 | 6 | — | — | 33 | 5 |
| Middlesex ... | 8 | 2 | 1 | 2 | 4 | 17 | — | 2 | 11 | 30 | 80 |
| Berkshire... ... | — | — | — | — | 3 | — | — | — | — | 10 | — |
| Wiltshire ... ... | — | — | — | — | 3 | — | — | — | — | 16 | 155 |
| Somerset ... ... | — | — | — | — | 1 | — | — | — | — | 6 | 12 |
| Kent ... ... | 23 | 7 | 1 | 10 | — | 3 | — | — | 2 | 12 | 39 |

SMALLPOX CASES, 1919–1929. ENGLAND AND WALES—*cont.*

| County. | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 | 1929 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Surrey ... ... | 10 | — | — | — | 2 | 1 | — | 2 | 4 | 33 | 16 |
| Sussex ... ... | 2 | — | — | — | — | — | 1 | — | — | 24 | 9 |
| Southampton ... | 8 | 2 | 10 | 3 | — | — | — | — | 3 | 10 | 4 |
| Wight, Isle of ... | 12 | — | — | — | — | — | — | — | — | — | — |
| Cornwall ... ... | — | — | — | — | — | — | — | — | 2 | 1 | 2 |
| Devonshire ... | — | — | — | — | — | — | — | — | 1 | 32 | 2 |
| Shropshire ... | — | — | — | — | — | — | — | — | 1 | 4 | — |
| Dorset ... ... | — | — | — | — | — | — | — | — | — | 3 | 13 |
| Huntingdon ... | — | — | — | — | — | — | — | — | — | 10 | 53 |
| Rutland ... ... | — | — | — | — | — | — | — | — | — | — | 1 |
| Wales and Mon. Anglesey | — | — | — | — | 1 | — | — | — | — | — | — |
| Wales and Mon. Carnarvon | — | 1 | — | — | — | — | — | 1 | — | — | — |
| Wales and Mon. Flint | — | 1 | — | — | — | — | — | — | — | — | 1 |
| Wales and Mon. Monmouth | 2 | 1 | — | — | 8 | — | — | — | 1,907 | 1,232 | 522 |
| Wales and Mon. Glamorgan | 15 | — | — | 4 | 17 | — | 1 | — | 455 | 904 | 532 |
| Wales and Mon. Brecknock | — | — | — | — | — | — | — | — | 59 | 103 | 19 |
| Wales and Mon. Carmarthen | — | — | — | — | — | — | — | — | 1 | — | 1 |
| LONDON. | 25 | 20 | 2 | 65 | 11 | 4 | 10 | 5 | 5 | 296 | 1,903 |

LONDON SMALLPOX NOTIFICATIONS, 1922–1929.

| District. | 1922. | 1923. | 1924. | 1925. | 1926. | 1927. | 1928. | 1929. |
|---|---|---|---|---|---|---|---|---|
| City of London .. | — | — | — | — | — | — | — | 3 |
| Battersea Met. B. | — | 1 | — | — | — | — | 1 | 2 |
| Bermondsey ,, ,, | 1 | — | — | — | — | — | 1 | 46 |
| Bethnal Green ,, ,, | 1 | — | — | 11 | — | — | 4 | 262 |
| Camberwell ,, ,, | — | 1 | — | — | — | — | 2 | 117 |
| Chelsea ,, ,, | — | — | 1 | — | — | — | 1 | — |
| Deptford ,, ,, | — | — | — | — | — | — | — | 15 |
| Finsbury ,, ,, | — | 1 | — | — | — | — | 1 | 32 |
| Fulham ,, ,, | 2 | — | — | — | — | — | 1 | — |
| Greenwich ,, ,, | — | 4 | — | — | — | — | — | 1 |
| Hackney ,, .. | — | 1 | — | — | — | 3 | 1 | 58 |
| Hammersmith ,, ,, | — | — | — | — | — | — | — | 3 |
| Hampstead ,, ,, | — | — | — | — | — | 1 | — | — |
| Holborn ,, ,, | — | — | — | — | — | — | 1 | 43 |
| Islington ,, ,, | — | — | — | — | 1 | — | 4 | 70 |
| Kensington ,, ,, | — | — | 1 | — | — | — | — | 5 |
| Lambeth ,, ,, | 1 | — | — | 2 | 1 | — | 52 | 70 |
| Lewisham ,, ,, | — | 1 | — | — | — | — | — | 8 |
| Paddington ,, ,, | — | 1 | — | — | — | — | 5 | 4 |
| Poplar ,, ,, | 50 | — | — | — | — | 1 | 68 | 158 |
| St. Marylebone ,, ,, | — | — | — | — | 2 | — | 30 | 3 |
| St. Pancras ,, ,, | 1 | — | 1 | — | 1 | — | 3 | 87 |
| Shoreditch ,, ,, | — | — | — | — | — | — | 3 | 246 |
| Southwark ,, ,, | 2 | — | — | — | — | — | 21 | 153 |
| Stepney ,, ,, | 5 | — | — | — | — | — | 4 | 489 |
| StokeNewington ,, ,, | — | — | — | — | — | — | — | 6 |
| Wandsworth ,, ,, | — | — | — | — | — | — | 88 | 15 |
| Westminster ,, ,, | — | 1 | 1 | — | — | — | 2 | 2 |
| Woolwich ,, ,, | — | — | — | — | — | — | 3 | 5 |
| West Ham C.B. | 3 | 2 | — | — | — | 1 | 64 | 1,277 |

## Difficulties in Controlling Variola Minor.

The fact that variola minor succeeded in establishing itself in the districts in which it is now endemic may in particular instances be attributed to some defect in the application of the ordinary machinery of prevention, to a large initial series of cases going unrecognised or being mistaken for chickenpox, to the action of the Medical Officer of Health or the Public Health Department having been too long delayed, or be otherwise explained. No doubt in several such cases the circumstances in which the disease originally spread could have been obviated by greater vigilance. It must, however, be admitted that when dealing with variola minor the problem of prevention is very much more difficult than with variola major.

In the first place the difficulty of unrecognised cases is considerable. Their identification or notification as smallpox is often delayed beyond the point at which their contacts can be usefully vaccinated. In the second place vaccination of contacts is less readily accepted in a district in which the public has come to realise that the current smallpox is not a killing or even disfiguring disease, and that (at least for considerable portions of the community) the residence for a few weeks in a smallpox hospital which is required if the contact gets smallpox causes no great hardship or inconvenience. Similarly, in the absence of general public alarm, or after its subsidence, the difficulties of making enquiries and tracing persons who have been exposed to infection are increased.

It is the common experience of the invaded areas that if people do not feel seriously concerned they do not put themselves out to give information to the Health Authorities, or, if they are contacts, to be available for inspection or inquiry during the critical days. There is less feeling of civic conscientiousness regarding a malady thought to be trifling than there is with one known to be severe. Moreover, even in an area in which it has become endemic, people will have different ideas of what smallpox signifies. Employers and employees may both take the extreme view and on a whisper of the word "smallpox" will declare that they will take no risks. Employees will consequently be reluctant to let the fact of their exposure to infection be known in their places of employment. They have sometimes a very material reason, as often where the Medical Officer of Health has made enquiries about contacts at the places of their occupation, the contact has been suspended from work or lost his employment. Similar effects may follow action, not of the employers, but of the contact's fellow-workers. Assurances of the Medical Officer of Health that the contact creates no risk to his fellow-workers unless the initial symptoms of the disease have occurred are often not regarded ; neither is sufficient confidence placed in the fact that a contact who has been promptly identified after his exposure to infection, and been vaccinated successfully, will in all probability remain healthy and immune to smallpox. Whereas in some areas, when there has been actual exposure to infection, it is the

exception for persons to refuse vaccination for themselves or for their families, this is not always the case. In many parts of the country refusal is the rule. Recent inquiries in Shoreditch and Poplar showed that notwithstanding much painstaking explanation, hardly more than 20 per cent. of contacts would consent to be vaccinated. Contrasts are drawn between the fate of those who during their short illness have been maintained for some weeks in comfort in a smallpox hospital at the public expense, with that of others who for a similar period have had to go about their ordinary work or business with the inconvenience of a vaccinated arm. The prominence which has been given to the occurrence of post-vaccinal encephalitis, to which reference is made below, has also influenced the acceptance of vaccination even after exposure to infection.

We have, therefore, the situation that for several years in certain parts of the country, and more recently in considerable parts of London, variola minor continues to smoulder notwithstanding great efforts in contact-tracing and for the promotion of the vaccination of contacts, efforts which have in many cases required the employment of additional or special staff and considerable expenditure, particularly in the hospital isolation of cases*—and all in relation to a disease which, if taken by itself, has no more formidable consequence than the familiar chickenpox or varicella, which neither the general public nor the public health authorities regard as a disease requiring any intervention by the medical officer of health or action or expenditure on the part of the public health authority.

## Dangers of Neglecting Variola Minor.

Some Health Authorities and Public Health Officers, in areas in which variola minor has for some years been prevalent and has maintained itself in spite of all the measures taken, have not unnaturally come to question whether the prevention of variola minor should any longer be attempted, at least on the same lines as variola major. To leave cases of variola minor alone and let the responsibility of their treatment and isolation rest with the individual householder or the private practitioner, as in the case of chickenpox, would certainly in these districts be a great relief to an over-worked and possibly discouraged staff, while from the point of view of the ratepayer considerable expense would be saved by dispensing with the mass of individual enquiries and still more by the reduction in the bill for hospital isolation.

It has even been urged in support of such a change of practice that by letting the variola minor run its course in this way through a local population little harm would be done *qua* sickness, still less

* The cost of isolating each case of smallpox in London is reckoned at £15—an average sum per head which may be exceeded in some other areas. Many districts have made considerable temporary additions to the staff of their public health departments solely on account of smallpox work, and naturally evince anxiety at the prospect of these having to become permanent.

*qua* mortality, and that the result would be positively beneficial, in the event of variola major being imported into the area. A large proportion of the population, so far as it is susceptible to variola major at present, will in a short time be immune to that disease because of the immunity they will have obtained by having had an attack of variola minor, or because of their having been vaccinated on account of that disease. Perhaps few would seriously advance this extreme view, but there is a tendency on the part of a much larger number of public health officers to favour some middle course according to which the public health authority, while accepting it as being as natural for the time being to have a certain amount of variola minor in its district as it is to have varicella, and while continuing to use its notification system, hospital isolation and contact vaccination for it, would do so only to an extent which is judged to be practicable and reasonable ; the fact that it is a matter of " smallpox " giving it no special preference over other work. It may be added that from the opposite side anti-vaccination publications appear usually to advocate allowing variola minor to be left alone without any official action of any kind for its prevention. The ordinary anti-vaccination contention is that the label " smallpox " or " variola " is only attached to variola minor by the doctors as a piece of pedantry. The disease, it is said, may have some relation to severe smallpox, but in fact it is just a simple rash of no consequence, and the advocacy of vaccination to prevent its spread is only another manifestation of the medical instinct for seizing every occasion to beat the vaccination drum.

The consequences of following extreme counsels and allowing variola minor to run through the population uncontrolled would, however, from some points of view at least, be sufficiently serious. It must not be forgotten that it is an illness, sometimes far from negligible from the individual point of view, and that if at the present time it lingers in certain centres, in others its establishment has often quite successfully been checked. The prevention of a mass of invalidity from any cause is not to be discouraged. There is moreover the public point of view. An individual case of variola minor, with an extensive rash, is an unpleasant and even alarming object, and what is accepted for chickenpox in like circumstances might not here be as readily assented to. The popular outcry against such cases not being at once taken off to hospital would be much more vocal than that of ratepayers and critics who maintain that the isolation is not worth the money and effort.

## Some International Considerations.

Some wider considerations also arise. There are countries in the West Indies and South America, for example, in which variola minor appears to go on with comparatively little attention from the authorities, and there are other countries, notably the United States, in

which, like our own, the most energetic efforts of public health authorities have not succeeded in extinguishing the disease. But it remains the fact that England and Wales is at present time the only European country in which examples of variola minor can be found at all. It gradually disappeared from Switzerland four years ago, and it was lately promptly extinguished (assuming it to have been variola minor in that case) in Holland. The abandonment of any public efforts to control it in this country would certainly be regarded on the Continent with its well and repeatedly vaccinated populations as reactionary and of little credit to the high reputation which we hold in the matter of disease prevention. Such a continental opinion might lead to practical inconvenience in more than one way. Variola major and variola minor are both types of smallpox, and the European countries which have not hitherto had much or any experience of the latter, and do not share our apprehensions in the matter of vaccination, are liable, however unreasonably, to be sceptical about its difference from the variola major which they know and consider they can always master. And if they did accept it as a relatively trivial disease, they would still not want to see it imported from England, because England took no trouble over it.*

The international obligation regarding the declaration of the occurrence of epidemics of smallpox to other countries which is imposed by Art. I of the International Sanitary Convention, 1926, refers simply to "smallpox" or "variola." But it provides a special means by which a country affected by a smallpox epidemic of a particular kind can notify the nature of the outbreak to other countries, along with an account of the measures of control which are adopted, and their results. It is now the practice of the Ministry of Health to forward every quarter to the International Health Office at Paris, and through it to the principal public health authorities of the other Governments signatory to the Convention, an official statement regarding the clinical character, mortality and local spread of variola in this country, explaining where it has been consistently variola minor or where it has occasionally, as in the case of the s.s. "Tuscania," been complicated by the intercurrent introduction of variola major. These declarations have proved of great value in securing a satisfactory appreciation of the smallpox

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* The unexpected action taken at the French ports in April, 1929, when all passengers from England were required to produce evidence of vaccination within five years as an alternative to 14 days' surveillance, arose in the first instance over exaggerated reports regarding the introduction into England of severe smallpox by passengers on the s.s. Tuscania. Until the situation was cleared, and the French requirement was taken off, it was widely assumed that the two or three hundred notifications of smallpox per week in this country were not our customary variola minor, but the severe smallpox of which such serious accounts had been given. Even in the case of variola minor, demands are made from time to time at continental ports that crews of ships coming from British ports at which smallpox is reported should be vaccinated.

situation in this country by foreign administrations, which otherwise would be disposed to exact special precautions on the arrival in their territory* either of passengers from England or of goods which might be presumed to harbour smallpox infection. Also, it is now the practice (Circ. 1021) for medical officers of health to inform the Ministry at once of contacts of smallpox who have gone overseas, and the Department on this information communicates at once with the foreign health administration concerned with a view to the continuance of the surveillance which remains necessary.

Following the attention which the question has received, and the adoption of this system, there is little probability that discriminating action against English citizens or English merchandise will be taken so long as the present situation remains ; in other words so long as it is realised abroad that the prevalence of variola minor remains localised to certain areas in which it is being combated by all measures in the power of the public health authorities under the active supervision of the central Health Department, even if they have not led to its extinction. The adoption, however, of a policy under which official measures were in future to be limited to variola major only, while the minor type was allowed to go uncontrolled, would almost inevitably give rise on the Continent to new doubts and misrepresentations regarding smallpox in this country, and these might well have inconvenient reactions in the case of persons travelling from this country abroad and possibly in the case of certain important trades.

## Some Changes to be Considered in the Present Procedure.

We come then to the practical point of enquiring whether, given the circumstances, there are any modifications of practice which would make the control of variola minor by the local authorities easier, less costly, and if possible more effective, even though they do not succeed in extinguishing the disease. Here the first question which of course arises is the practicability of dealing radically with the whole matter by requiring or securing that practically the whole population of the locality, or of the entire country, is immunised against any form

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* Under Articles 1 and 2 of the International Sanitary Convention, 1926, each Government undertakes, inter alia, immediately to notify other Governments and the International Health Office in Paris of the existence of an epidemic of smallpox, and to follow that notification by detailed information, which includes the origin and type of the disease, the number of cases and deaths, measures taken, etc. Precautions against importation of smallpox by sea are dealt with in the same Convention by Article 42, which, after prescriptions relating to ships which have or have had smallpox on board, contains the declaration that " It rests with each Government to take, after disembarkation, the measures which they consider appropriate to ensure the surveillance of persons who are not protected by vaccination, and who arrive on a ship which has had no case of smallpox on board, but who have left a local area where smallpox is epidemic within the previous fourteen days."

of smallpox by repeated vaccinations. This will most conveniently be considered in the third section of this review, which relates to the Vaccination Acts. Meanwhile, and apart from such a solution, are there any suggestions to be made for action on the first occurrence of variola minor in a district, or at a later stage when this disease has taken hold in an area and become endemic ?

*First occurrence in a district.*—As regards first occurrence, there seems little new to suggest either on the first appearance of variola minor in a district previously free from the disease, or on its reappearance in a district in consequence of a new source of infection. It is then on every ground desirable that the medical officer of health and the public health department should, notwithstanding pressure of other work, give their first attention to the first notification or group of notifications of smallpox and should spare no effort, along with the isolation of the patient in hospital and the necessary disinfection, to vaccinate and trace all those who have been in contact with the patient since the onset of his illness, and to ask all medical practitioners and others likely to meet with smallpox to be on the alert. At the same time the medical officer of health should warn the medical officers of health of other districts of contacts belonging thereto, and notify the Ministry of Health by special report of the circumstances of the case and the action taken. In support of this advice reference may again be made to the Table on p. 21 shewing how frequently in recent years an outbreak of smallpox in a district has been cut short at the first group of cases. Caution prevents the claim that in all these cases the extinction of the disease was the direct outcome of the energies of the medical officer of health, but the detailed accounts and reports leave little doubt of their essential share in producing this result. The procedure moreover has the advantage that it is identical in all respects with that taken for variola major. While it is often practically certain, it is seldom absolutely safe for a medical officer of health to conclude that the first appearance of smallpox in his district is of the minor variety. This may be present in the adjoining local areas, but there is always the possibility of origin from another source of infection which may have been variola major. The observation of a small number of cases, coupled with their history, will soon suffice to satisfy him in regard to the variety of smallpox with which he is dealing, but in any case at this early stage the question of the particular variety will be of little consequence seeing that the action taken and required is in all respects identical for the two varieties.

*Action where disease established.*—Where, despite this action, or because of its omission, variola minor has continued in a district for some months, the question becomes one of economy of money and effort. Owing to the occurrence of cases so slight that they are not detected or notified, or on account of contacts declining vaccination, or for other reasons, cases of variola minor may occur month

by month in the area, and increase at fitful intervals, particularly in the winter and spring of each year. The prospect is then that variola minor must be reckoned as one of the infectious diseases with which the local authority and its health department will probably for some years be required to deal.

When this rather pessimistic view has been taken, it should be remembered as an encouragement that in the case of any variety of smallpox there are powerful factors which make for prevention of its spread that are not operative in the case of an endemic disease like scarlet fever. With the latter disease the many advantages of treatment in infectious diseases hospitals cannot be said to include the making of any great reduction in the prevalence of scarlet fever.* But with any kind of smallpox, control is favoured by the almost complete absence of any infective ability of the individual case until the first symptoms of illness have occurred, and by the ability of producing immunity of a contact if only his vaccination can be performed within forty-eight hours after exposure to infection. Practically speaking, there is no "healthy carrier" problem in the case of smallpox. Cases of variola minor appear from time to time which are so extremely slight that they pass unrecognised, just as with scarlet fever, but for the above reasons, given effective enquiry as to contacts, they should be relatively fewer, and much more easily identified and prevented from spreading infection.

*Local judgment.*—The exact action which should be taken in a given district to combine the maximum of prevention with reasonable economy of effort on the part of the public health authority is essentially a matter for local decision and local responsibility; no attempt to stereotype an official procedure in all districts is desirable, or indeed would be desired by any competent medical officer of health or his staff. It can, however, be said that, to judge from the reports received from districts in which variola minor has been for some time epidemic, local authorities need not, and should not, carry on the work on the principle that all the procedures which would be applicable in the case of a major smallpox epidemic must necessarily be applied to the minor. By attempting to so so they may well find that the work required far exceeds the powers of their staff to undertake. If it should be claimed that the official requirements of the Ministry of Health, or the advice habitually given by the Ministry based essentially on the prevention of variola major, as exemplified in Memorandum 71 (*a*) Med., 1922, in practice discourage medical officers of health from designing appropriate preventive plans specially applicable to their endemic variola minor, the Department would find no difficulty in meeting the case and assenting—so far as its assent is necessary—to any reasonable administrative

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* Some Administrative Aspects of Scarlet Fever," by Dr. A. C. Parsons (Reports on Public Health and Medical Subjects, No. 30, 1927, page 176).

practices which seem advisable. And in some respects it may be possible for it to strengthen the hands of local authorities generally by epidemic regulations or otherwise, in meeting particular difficulties.*

*Hospital isolation.*—There is no infectious disease of common occurrence in this country, other than smallpox, of which it can be said that every case practically without exception is at once isolated in hospital. For every other infectious disease, for instance, scarlet fever, enteric fever and to a much larger extent measles, the use of the isolation hospital is a matter of discretion, exercised largely in the interest of the individual case. The amount of hospital isolation given is regulated by the accommodation available, and if this accommodation is fully taxed arrangements are made for supervision and nursing of patients at their homes. In the case of variola minor, if the smallpox hospital accommodation normally available for a district is already fully occupied, the question arises whether the risk may justifiably be taken of allowing a patient to remain at home if he can be reasonably isolated there and all the other occupants of the dwelling are protected by prompt vaccination.

A further question which arises is whether cases of variola minor may properly be isolated in a hospital ordinarily used for other diseases if the normal smallpox hospital accommodation is either already fully occupied or is out of action through being used for other purposes. The Central Department has always taken the view that a hospital should not be used at one and the same time for the reception of cases of smallpox and of other infectious diseases. But it has been represented that, in the case of variola minor, there might be little risk of the spread of this infection to patients admitted to a hospital for other infectious diseases if patients suffering from variola minor were treated in an isolation block or in special wards at such a hospital and the hospital staff were fully protected by vaccination, and if the administration of the hospital were in every respect careful and thorough.

Both these questions, which are partly social as well as medical, can properly be decided, if and when they arise, only by the responsible Local Authority, acting on the advice of their M.O.H., and with a full knowledge of all the local circumstances.

*Co-operation with medical practitioners.*—It may be questioned whether at present in all cases sufficient advantage is taken by the public health authorities of the co-operation which could be given by the medical practitioners of the district. Prompt notification is of the first importance, but it must occasionally happen

* The practical difficulties of applying all the recommendations of the Ministry's 1922 memorandum, and the disproportionate cost entailed by attempting to do so, have lately been represented by the Metropolitan Branch of the Society of Medical Officers of Health and by the Metropolitan Borough Councils of St. Pancras and Poplar, as well as by other authorities.

that a medical practitioner fails to inform the medical officer of health of a case which he suspects to be smallpox. Indeed, the diagnosis of slight cases of variola minor is not always easy, and it is still the case for large parts of the country that the disease is one with which the ordinary general practitioner is not personally familiar. Textbook descriptions of smallpox in this matter are apt to be misleading seeing that they relate so generally to the severe form of the disease. The issue therefore to medical practitioners of up-to-date clinical accounts of variola minor would have its advantages. If there were a desire for it on the part of medical officers of health, a series of typical and well illustrated descriptions, together with appropriate leaflets for communication to the patient or those responsible for his welfare, might be prepared.

In this respect also the practice of some of the larger local authorities of arranging for the services of medical men conversant with smallpox to act as consultants deserves every encouragement. And probably there is no practical measure which would secure the closer co-operation of medical practitioners with the public health authority in this matter than the knowledge that they could obtain vaccine lymph from the medical officer of health for immediate use by them in any suspected case of smallpox, for the vaccination of persons in the household, or of other contacts. Hitherto this has not been encouraged by the Ministry of Health on the ground that lymph supplied to the medical officer of health for the vaccination of contacts should only be utilised by himself or by assistant medical officers of health. There were certain conveniences in this official attitude. It made it more certain that the use of the lymph, and the results of the vaccination, were recorded and reported by responsible officials. At a time when it was made a condition of the supply of lymph that vaccinations should be effected according to regulations prescribing that a relatively large area of vesiculation should be aimed at, if possible with four marks, the smaller the number of responsible persons who were supplied with lymph for contact vaccination, the more these conditions were likely to be strictly observed and supervised. But now, when a minimum rather than a maximum area of vaccinated surface is officially advocated, further consideration might well be given to proposals which would allow the Medical Officer of Health in times of smallpox prevalence to distribute lymph supplied to him from the Government Lymph Establishment to medical practitioners, subject only to the usual conditions of authoritative supervision and of keeping, or ensuring, the appropriate records of the vaccinations done. It will be understood that these suggestions relate to the vaccination of contacts and to epidemic periods, and may be considered in addition to the normal work of the public vaccinator or to the attendances he sometimes gives during epidemics at specially opened vaccination stations. They are equally, perhaps more strongly, applicable to vaccination in presence of variola major.

*Contacts.*—Reports from districts in which variola minor has been for some time endemic, and in which the resources of the public health department are in consequence heavily taxed, show that much time is sometimes consumed in compiling lists of persons who have been in indirect contact with the patient throughout the incubation stage of the disease. Economy of effort could apparently be secured, with very little loss of efficiency, by concentrating only on those who have been contacts with the patient from the time of his first sickness down to the appearance of the rash and his isolation. Again, the personal visitation of contacts, other than those in the infected houses, might in many cases be replaced, without material loss of efficiency, by notices from the office of the medical officer of health. If, as often happens, the patient ordinarily works in a factory, office or other establishment employing a large number of people, it may prove best, for economy of effort, to deal primarily with the contacts in his house and only in special cases with contacts at his place of employment. If there, by taking the employees in block, vaccination could be assured, such action would be all to the good. But experience shows that with this mild type of smallpox no such mass vaccination is usually agreed to, and the attention attracted, either on the part of the management or on the part of the employees, to indirect contacts may merely give rise to difficulties and questions which occupy time that could more appropriately be used in other directions.

Finally, it is clear that a great deal of the work of tracing contacts could be simplified if the medical officer of health were in possession of greater authority to undertake the observation of contacts.* For all smallpox, but particularly for variola minor, the heaviest demand on the personnel of the Public Health Department results from the frequent visiting of contacts to ascertain whether they have been attacked during the critical days after exposure and in getting a proper medical examination of them to see if they have developed a rash. The contacts often do not take the matter seriously. It may be difficult to find them at home or to trace their movements. The whole of this work would be greatly facilitated if authority were given to the Medical Officer of Health by notice to require a contact to present himself individually at a specified time at the Public Health Offices, clinic, or other place where there would be

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* Regulations by the Ministry for smallpox, such as have been made for certain other infectious diseases in the Public Health (Infectious Diseases) Regulations of October 19th, 1927, may be considered in this connection. In the case of typhus, these Regulations empower the Medical Officer of Health to require by notice that the inmates of the building or other persons recently in contact should be segregated for a period to be specified until their persons and clothing have been appropriately dealt with. In the case of enteric fever, where the Medical Officer of Health is of opinion that such a course is necessary to prevent the spread of infection, the Regulations empower him to move the local authority to require various special measures to be taken until further notice. The principle, therefore, is not a new one.

adequate arrangements for personal examination, a doctor, and a nurse—the hour would be arranged to suit the reasonable convenience of the contact, and evening attendances could be provided. If and when the contact feels unwell, the notice should require him to be at his home for medical inspection on a particular specified day or hour. Such provisions would be still more useful and practical when dealing with variola major.

*Contact vaccination.*—The above suggestions for modifying or giving more elasticity to the ordinary procedures of public health authorities omit (leaving for later consideration) the question of the extent to which the position could be changed by modification of the Vaccination Acts. Here, however, it may be pointed out that if these Acts were to be radically changed in the direction of removing from them what at present exists of compulsion, there would still be a class of case, not included in present legislation, for which compulsion would seen justified on every ground of preventive medicine. This is the case of the person, unprotected by recent vaccination or by previous smallpox, who is known to have been exposed to smallpox infection at a time when his prompt vaccination will in all probability prevent the development of the disease. Compulsory vaccination in these circumstances, under penalty for non-compliance, is provided for by the legislation or administrative procedure of most other countries, whatever may be their requirement for systematic vaccination in the absence of smallpox.

It is important that the routine measures against variola major should be maintained at maximum of application. It should be emphasised that the suggested modification of certain measures of control which may be regarded as justifiable applies primarily to cases when the Medical Officer of Health is satisfied that he is, in fact, dealing with variola minor. Further, the possibility of variola major being introduced into a district in which variola minor is present must never be lost sight of, and the Medical Officer of Health should constantly be on the outlook for any indication of the occurrence of cases differing in character from those of the prevailing type.

## II.

# POST-VACCINAL ENCEPHALITIS: ITS RELATION TO AND EFFECT ON CONTROL OF SMALLPOX BY VACCINATION.

The Committee on Vaccination (Chairman—Sir Humphry Rolleston) was appointed in February, 1926, by the Minister of Health, in conjunction with the Medical Research Council, and was charged to enquire and report from time to time: (i) on matters relating to the preparation, testing and standardisation of vaccine lymph; (ii) on the practical methods which are available in the light of modern knowledge to diminish or remove any risks which may result from vaccination; (iii) on the methods of vaccination which are most appropriate to give protection against risk of smallpox infection in epidemic and non-epidemic periods; and to co-ordinate the work of investigation on these questions in this country and abroad, having regard to corresponding work undertaken by international health organisations.

The Committee, in their first Report* published in July, 1928, stated that they had enquired, *inter alia*, into the risks attendant on vaccination and had examined the alleged ill-effects consequent on vaccination before and after the passing of the Vaccination Act, 1898, and the subsequent Order, which embodied most of the recommendations of the Royal Commission of 1889–96 and which introduced far-reaching reforms. The number and nature of these ill-effects were considered and the Committee found that, although their character remained substantially the same after the Act and Order became operative as it had been before, a great diminution had taken place in the number of deaths referred to vaccinia, whatever the nature of the immediate cause, excepting those (other than convulsions) relating to the central nervous system. Moreover, in 1923 terms suggesting an affection of the nervous system, hitherto unrecorded in this connection, appeared on the certificates relating to 6 out of 8 deaths classified to vaccinia and at the same time similar cases were being reported on the Continent. The details relating to 93 such cases (63 of which were considered by the Andrewes Committee, whose report the Rolleston Committee incorporated into their own) were considered in all their aspects. On the causation of this condition the Committee wrote:—

> "Whereas in our opinion the available evidence acquits vaccinia virus of being the sole cause of this complication, we are unable to exonerate vaccination from playing some part in its causation. The recent

* Report of the Committee on Vaccination, H.M.S.O., 1928, Cmd. 3148, price 7s.

histological researches of Bouman and Bok in Holland and of Perdrau in this country are of considerable interest, in that they brought to light in post-vaccinal nervous disease a lesion of the central nervous system probably similar to that found in the nervous sequelae which have, more particularly in recent years, been observed to follow certain of the exanthemata, and which has certain resemblances to the early lesions of disseminated sclerosis. How far the acute nervous complications that may occasionally follow the exanthemata find a parallel in those following vaccination, it is at present impossible to decide. There is a body of opinion favouring the view that the nervous complications of the exanthemata (measles, chicken-pox, mumps, etc.) are due solely to the particular virus concerned, while other clinicians favour the hypothesis of combined virus action similar to that postulated by the Andrewes Committee in the case of post-vaccinal encephalitis. It is our considered opinion that the co-operation of vaccinia with the viruses of poliomyelitis or of encephalitis lethargica or possibly some unknown neurotropic virus harboured by a vaccinee must for the present be retained as a working hypothesis of causation pending further research into the nature and properties of neurotropic viruses in general."

The Committee made the recommendations which are set out below. Primarily these are directed to diminishing the risk of sepsis, and recommendation (2) is based on the Committee's observation that the majority of cases of post-vaccinal nervous disease, both in this country and abroad, have followed the primary vaccination of children of school age. The recommendations were that :—

(1) In place of the officially advocated four insertions, trial be made of vaccination and re-vaccination in one insertion with a minimum of trauma, and that multiple scarification and/or cross-hatching be deprecated.

(2) Primary vaccination be performed in infancy, between the ages of two and six months as at present, and that re-vaccination be offered at the time when a child enters school (5 to 7 years) and again on leaving (14 to 16 years).

(3) Vaccination in multiple insertions be available for such persons as desire to obtain the maximum protection against smallpox obtainable at one operation.

(4) In public vaccination, parents be informed that, if in consequence of vaccination, a child requires medical attention, it is the duty of the public vaccinator concerned to provide such attention without cost to the parents.

(5) Instead of the one nspection now required in the case of public vaccination, there be two ; the first not earlier than the seventh or later than the tenth day, and the second not earlier than the fourteenth or later than the seventeenth day.

(6) A partial reversion to the principle of stational vaccination be considered.

(7) The syllabus of instruction in vaccination of medical students be revised in the light of present-day knowledge and of these recommendations.

(8) Experimental observations be made to ascertain if it is feasible to increase the dilution of vaccine lymph beyond the present degree without impairing its efficacy.

(9) Provision be made for the continuance of experimental investigation with a view to the furtherance of knowledge of vaccinia and of the virus diseases in general, with special reference to the pathogenesis of the nervous complications which occasionally follow those diseases.

(10) Steps be taken to impress upon the public mind the nature and purpose of vaccination.

The Minister gave effect to a number of these recommendations by the issue of the Vaccination Order, 1929, which came into force on the 1st October of that year. The principal alteration effected by this Order is to permit of vaccination by public vaccinators in one insertion, and so long as the smallpox prevalent in this country retains its present mild character, to discourage the primary vaccination of children of school age and of adolescents unless they have been in personal contact with a case of smallpox or directly exposed to smallpox infection.*

A second Report† of the Committee has recently been published. It is in effect a continuation of Part II of the Report of July, 1928. It consists of a critical analysis of 90 cases of post-vaccinal nervous disease which occurred in the two years subsequent to the period dealt with in the first Report, and in respect of 25 fatal authenticated cases correlates the available clinical information with the post-mortem findings. Some account is given of four cases presenting a similar symptomatology and pathology but following variola (1), measles (1) and influenza (2). The Committee report that there is nothing in the circumstances of the cases described in their further Report which has not its parallel in their previous experience, and they see no reason to modify the tentative hypothesis of the causation of post-vaccinal encephalitis which they postulated in their first Report. The evidence set out appears to prove the histological identity of encephalitis whether following vaccinia, variola, influenza or measles. The Report concludes with some observations on the treatment of post-vaccinal encephalitis with the serum of convalescents and in an appendix is a review of the position from an international standpoint.

The most ordinary, innocent and necessary occupations of common life carry with them some element of risk, however slight, and vaccination is no exception. It is, in particular, a process which involves an abrasion of the skin, and so, like any other abrasion, even when carefully looked after, is liable in the exceptional instance to result in accidental septic infection. In the last century, when septic infections of all kinds were common, the occasional occurrence

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* A comparison of returns made to the Government Lymph Establishment by Public Vaccinators in the nine months ending the 30th September, 1929, with those made in the following nine months indicate that in the first period the average number of insertions of lymph made in 199,254 primary vaccinations was 3·7 with a case success of 98·8 per cent. and an insertion success of 95·7 per cent. In the second period the average number of insertions made in 177,508 primary vaccinations was 1·2 with a case success of 96·9 per cent. and an insertion success of 95·8 per cent.

With regard to re-vaccinations ,in the first period the average number of insertions made in 92,561 re-vaccinations was 3·7 with a case success of 95·9 per cent. and an insertion success of 89·9 per cent. The corresponding figures in respect of the second period were 42,654 cases, 1·2 insertions, case success 93·3 per cent. and insertion success 91·5 per cent.

† Further Report of the Committee on Vaccination, H.M.S.O., 1930, Cmd. 3738, price 2/6.

of erysipelas or sepsis in a vaccinated arm was accepted as an incidental drawback to vaccination, but nevertheless to be treated as an accident which thoughtful people would not for a moment allow to weigh in the balance against the formidable menace of smallpox infection and its infinitely greater dangers. A risk of septic arms and their attendant consequences has not wholly disappeared even in the present days of knowledge of the causes and prevention of sepsis : but it has been greatly reduced. This subject was fully dealt with by the Committee on Vaccination in its first report. Whereas, during the period 1886–1891, the deaths ascribed to vaccination from diseases of the septic group (as classified by Dr. Ogle) averaged 47 per annum, the average for the same group for the period 1911–1925 was only 5 per annum.

In less degree, the same considerations applied to the other and rarer serious concomitant of vaccination—generalised vaccinia. This occurrence has also been known ever since vaccination was practised, but vaccination is not refused because of some highly unusual cases, in which the inoculation produces a generalised eruption accompanied by severe constitutional symptoms, as well as the usual vesicles on the arm. Such conditions are, happily, extremely rare in practice ; yet, as in all vaccine therapy, prophylactic or remedial, it is possible to have excessive reaction in unusually susceptible individuals, even with normal dosage ; but after all there are persons who have exceptional reactions to every condition of medical treatment.

Now, however, that a characteristic disease of the brain and nervous system has been shown (even though but rarely in a million vaccinations) to follow vaccination, notwithstanding every possible care in regard to the vaccine and the treatment of the arm, the question of the risks entailed by vaccination has become more serious.

It is instructive in this connection, to recall the proof, accepted by the Royal Commission on Vaccination (Final Report, 1896) that by vaccination with human lymph taken from a syphilitic infant it is possible to convey the infection of syphilis. When this was established as a fact, it made little difference to say that the risk was far less than that of innocently contracting the same disease from a syphilitic by other accidents. Little conviction was carried by emphasising the fact that the occurrence was so exceptional, and required such an unusual combination of circumstances, that it need not enter into the calculations of the ordinary citizen who was vaccinated or had his child vaccinated. The matter was not one which the public could be expected to treat philosophically with a nice sense of balance, and it led, in a very large measure, to the creation of anti-vaccination and conscientious objectors to vaccination. The remedy fortunately was at hand in that case. Replacement of human lymph by calf lymph, as was done universally after the legislation of 1898, removed this risk absolutely. In

the present instance no such absolute remedy has yet been found for post-vaccinal encephalitis. It is not yet proved that any modification of the vaccinal virus, or of the method of vaccination, can be made with the certainty that post-vaccinal encephalitis has been rendered impossible.

The complication is one which, from extensive home and foreign experience, has been proved not to be associated with any one class of lymph or method of lymph preparation, with any detail of technique of vaccination, or with the occurrence of any recognisable anomaly in the local course of vaccination. The balance of evidence seems to favour the assumption that an unknown and ordinarily harmless infecting virus unconnected with vaccinia has in the particular instance and for reasons not understood operated along with the vaccinia virus to produce the post-vaccinal encephalitis.

This was the view taken by the Committee on Vaccination, which based its conclusions on comprehensive study of the cases set out in its reports. It is not accepted in all quarters and the alternative theory chiefly favoured, though difficult to accept, is that the disease of the nervous system in these cases is merely an exceptional manifestation of the operation of the vaccine virus itself. On this view the occurrence of post-vaccinal encephalitis, so far as it is new, would represent a neurotropic ability inherent in the vaccine virus which has somehow become enhanced in recent years in anti-smallpox vaccine of all kinds in many countries. Another view is that the occurrence of these complications of the nervous system in the course of vaccination has the same explanation—whatever it may be—as the occurrence of closely similar symptoms and pathological lesions which have been observed after many acute infectious diseases, such as measles, influenza, or smallpox itself. If it is asked why, on this view, there has been such a conspicuous recent increase in encephalitis cases following vaccination with no such definite or demonstrated increase in encephalitis after acute infectious diseases, it would be replied that we are only now, in consequence of post-vaccinal encephalitis, beginning to realise the position; when affections of the nervous system following acute infectious diseases have received adequate attention and study they may prove to be much more common than is at present supposed, and be found responsible for a material number of cases which at the present time are diagnosed as "encephalitis lethargica" or other members of the group which is termed "infectious diseases of the nervous system."

### Conditions in which Post-vaccinal Encephalitis appears.

All these questions continue to be studied by the Department in connection with the post-vaccinal encephalitis occurring in this country since the Committee's Reports, and in relation to similar cases reported from other parts of the world. Meanwhile the practical

question requiring answer is whether we must assume that post-vaccinal encephalitis is a complication of vaccination which has permanently to be reckoned with, or whether there are indications that, however it is caused, it is only a passing phase in the history of vaccination ? And, if the first of these must be assumed, what are the present possibilities of guarding against it and of being able to offer vaccination with the assurance that this encephalitis risk cannot arise or is merely in the region of the one in a million chances which are ignored in the daily circumstances of ordinary life ?

To the first of these questions it must be answered that since post-vaccinal encephalitis was identified and began to be intensively studied some six or seven years ago it has continued to occur with little sign of abatement in the circumstances we have now learnt to consider favourable to its appearance. One circumstance has been fully proved at home and by foreign experience to be favourable, namely, vaccinating the child of school age, or the adolescent, for the first time, a consideration specially emphasised by the Committee on Vaccination. The Ministry of Health in their Circular of August, 1929, recommended that these ages should be avoided in public vaccination except in the case of children known to have been actually exposed to the infection of smallpox. In the extensive international studies* which have been made on this question, this preference of post-vaccinal encephalitis in matter of age appears to be the most important factor in determining both the geographical incidence and the number of cases in different countries of Europe. If, therefore, it were possible to use vaccination in the prevention of smallpox without vaccinating for the first time between the ages of say, 5 to 15, the seriousness of this complication might be very greatly reduced.

The experience of Holland during the extensive vaccination campaign of 1929 which followed the introduction of smallpox into Rotterdam and some other areas in that country is instructive. On an estimate, which is certainly a minimum, 77,344 vaccinations were done and as many as 1,196,465 re-vaccinations. This intensive vaccination campaign sufficed to extinguish the epidemic of smallpox in less than 6 months. But it was accompanied by at least 83 cases of post-vaccinal encephalitis, 52 after primary vaccination and 31 after re-vaccination. Owing to uncertainty regarding the figures of total vaccinations, exact ratios could not be determined. The Dutch authorities estimate that though no case occurred among the 16,000 primary vaccinations of infants under one, yet, taking the primary vaccinations as a whole, encephalitis occurred once out of every

* The Report of the Smallpox and Vaccination Commission of the Health Organisation of the League of Nations, August 1928 (C.H.739), as well as the first Report of the English Committee, discuss age incidence and other experience in foreign countries down to that year. The subsequent experience of post-vaccinal encephalitis in a large number of countries has since been reviewed fully by a special Committee of the International Public Health Office in Paris ,whose report was communicated to the English Committee.

2,300 vaccinations, and once among 815 vaccinations in the case of children primarily vaccinated at ages between 6 and 11. Certain cases occurred at higher ages among those vaccinated for the first time and others among the re-vaccinated, but here the risk was of an entirely different order. Post-vaccinal encephalitis occurred on an average only once in 50,000 re-vaccinations.

### Possibilities of Avoiding Post-vaccinal Encephalitis.

Turning now to the second question, which assumes a continuing risk but demands whether it can be effectively guarded against, reference should be made to the observations made by the Committee on Vaccination regarding the advantages of securing that the individual is vaccinated on several occasions throughout life, each time with comparatively small doses of vaccine. This recommendation was made by the Committee as being in the interest of the individual and as a means by which vaccination would be more readily accepted voluntarily by the population and not specifically because it represents a precaution against post-vaccinal encephalitis. The predilection of post-vaccinal encephalitis to accompany primary vaccination at school and adolescent ages, however, does clearly suggest that if the practice advocated by the Committee were generally adopted the danger of post-vaccinal encephalitis would to a very large extent disappear automatically. In other words we should be in the same position as countries like France, Belgium and Italy, all practically free from post-vaccinal encephalitis, in which vaccination is readily accepted and practised almost invariably in infancy, and followed by re-vaccination at school age. Primary vaccinations at the latter age or in adolescence then would very rarely be done.

It does not seem that at the moment any definite security against encephalitis can be promised by changes in the technique of either the preparation of lymph or of its use in vaccination. In the Dutch experience between 1923 and 1930 as many as 110 different lymphs have been employed, and cases of encephalitis were established as having occurred after the use of 41 of these. Neither the evidence available to the Committee nor that in the international reports tends to show that a lymph more diluted than that habitually employed would necessarily have any different effect, so long as it retains sufficient potency for successful vaccination. All vaccine lymphs at present contain a living virus. The practicability of using killed virus would seem at present to be remote, but the question whether it may be possible to produce a reasonable degree of immunity with vaccinia virus that has been modified, but not entirely destroyed, is a problem deserving further investigation and research. Even if a modified virus could not be relied upon to establish as long or as complete a protection as that afforded by the present vaccine lymph it might still be adequate to give temporary protection

which is all that might practically be needed during an epidemic period or in the case of a contact who has just been exposed to smallpox infection. If we had available a prophylactic which could be simply administered, say hypodermically, without causing any material inconvenience at the site of inoculation, or in the matter of reaction, and this was certain to confer an immediate effective immunity, we should be in possession of a very effective weapon with which to confront the prevalent variola minor.

Another line of investigation which is being pursued, but on which it is at present too soon to draw conclusions, lies in the possibility of making available some form of serum treatment, anti-vaccinal or other, which if promptly used on the onset of any symptoms suggesting post-vaccinal encephalitis would cut that complication short, or which could, if desired, be used in the case of normal vaccination as an additional precaution.

## Effect of Post-vaccinal Encephalitis on the Acceptance of Vaccination.

As things stand it must be admitted that the occurrence of post vaccinal encephalitis does present very considerable obstacles to the present control of smallpox. In connection with attempts at securing " mass " vaccination in a district invaded by variola minor, for example, we are met with cases like the City of Bristol in October, 1927, when within four weeks some 9,000 vaccinations were performed on children of school age and seven cases of post-vaccinal nervous disease occurred. By comparison with the classical examples of smallpox mortality in unvaccinated school children, notably that of Gloucester in 1895–6,* this is of course a trifling matter. When the Gloucester schools were attacked wholesale by variola major, something like one-fifth of all the children died from it, and many of the unvaccinated survivors were marked for life as a result of their attack. But this is hardly a legitimate contrast to draw. These rare nervous complications of vaccination—of no account in face of the major disease—are quite legitimately regarded as of very considerable account when the vaccination is pressed merely as a safeguard against the non-fatal and non-disfiguring minor variety.

Post-vaccinal encephalitis has, moreover, received very considerable prominence in the public press, particularly in connection with Coroners' inquests, and these reports have tended to create a general public suspicion of vaccination, the results of which are seen, not merely when " mass " vaccination is advised, but even in the case of persons who are known to have been exposed to smallpox and whom there would be time to protect by immediate vaccination. The practical effect of this on smallpox control has already been referred to (see p. 26).

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* Royal Commission on Vaccination 1897 Report, Appendix VII, p. 137.

*Effect of vaccination rules in special communities.*—It may be added that as a further result of the advice given by the Committee on Vaccination, and accepted by the Ministry of Health, to abstain from primary vaccination of school children and adolescents various communities in which for many years vaccination has been made a condition of admission or of employment, have now felt obliged to modify or dispense with this requirement. It is hardly logical, nor is it always practicable, to say that all new entrants into such a community must be vaccinated except those of a certain age.*

It is difficult to obtain evidence, sufficient to satisfy legitimate statistical demands, by which we can judge how far these communities, e.g., persons in the public services, railway companies, factories, etc., which have made it a practice to require vaccination on admission, have in fact been in a better position than other communities in regard to the absence of smallpox, seeing that some of them at least are rather specially liable to be exposed to infection. It may be presumed, however, that the vaccination rules they have hitherto applied have been of some benefit to the public as well as to the institutions. The existence of a number of communities with greater vaccinal protection than the average can hardly fail to be advantageous in the case of prevalence of smallpox, while the community which adopts the practice has the satisfaction of knowing that at least there is one disease which will rarely occur or produce invalidity among the staff. No one who realises what vaccination has done, and still does, to prevent smallpox can help regretting that the vaccination rules in these communities should thus tend one by one to weaken or disappear, but the process is a difficult one to check. If it is to be counteracted, it would seem again to call for the popularisation of voluntary acceptance of periodical and minimal vaccinations, beginning in infancy, which is advocated by the Committee on Vaccination.

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* Something of this kind has been attempted by the Civil Service Commissioners, who have waived their requirements as to evidence of vaccination in the case of candidates between 15 and 21. The General Post Office, which used to require all candidates to have been vaccinated unless they have evidence of having had smallpox or were prepared to make a statutory declaration of conscientious objection, has now modified its requirements so that in respect of persons under the age of 21 a mere written statement of objection will exempt them from the requirement. In the case of the Ordnance Factories, the Army Clothing Department at Pimlico and the Customs Waterguard Service, some similar questions have arisen and so far as the latter is concerned it has been considered no longer possible to make acceptance of vaccination a condition of entry.

III.

# ADVANTAGES AND DISADVANTAGES WHICH LOCAL AUTHORITIES DERIVE FROM THE VACCINATION ACTS IN REGARD TO CONTROL OF SMALLPOX.

The larger public health authorities, in consequence of the operation of the Local Government Act, 1929, have now taken over the powers and duties which formerly, under the Vaccination Acts, were imposed upon the Boards of Guardians. The questions which consequently have the greatest interest for them are, firstly, what has hitherto been secured by the administration of the Vaccination Acts under the Boards of Guardians in the way of producing a general immunity against smallpox, and secondly, how far the administration of these Acts now transferred to the health authorities, can be made more effective. How does it, or should it, dovetail into their other methods for the control of smallpox, and how far can it be used to improve that control ?

For the purposes of this review it is unnecessary to describe the machinery of the Vaccination Acts and the various Orders made thereunder by the Ministry of Health. The latter have recently been consolidated in the Vaccination Order, 1930 (Statutory Rules and Orders, 1930, No. 2) which has been placed on sale and communicated to the Councils which have taken over the duties. The Order specifies the terms of contract and duties of public vaccinators and vaccination officers, the forms in use, and all other matters relevant to the machinery ; the question here is rather what the machinery effects and can effect.

## Systematic Vaccination in the Absence of Smallpox.

On this point, some preliminary observations may be convenient regarding systematic vaccination as a safeguard against smallpox.

The case for requiring or applying any method of protection by immunisation against contracting the infection of smallpox is based upon the following propositions :—

(1) that recovery from an attack of smallpox is followed by a substantial and durable degree of protection against smallpox infection ;

(2) that this protection is due to natural immunisation, and that similar immunity can be artificially acquired by the inoculation of an immunising agent (vaccine) ;

(3) that such a vaccine must be derived, directly or indirectly from the specific or causative virus of the natural disease, if it is to exert a specifically protective effect ;

(4) that the vaccine must be harmless, *i.e.*, incapable of setting up variola or any other infective disease in the human body;

(5) that persons inoculated with the vaccine, when exposed to risk of infection under conditions similar to persons not so inoculated, contract infection less frequently or, if attacked, recover more readily than the unprotected.

In the 18th century, when smallpox was a very common disease, the rarity of second attacks was recognised and, indeed, prompted the introduction of smallpox inoculation. In respect of the last proposition, wherever large collections of data have been gathered, the fatality rate on vaccinated persons is always less, usually very much less, than on unvaccinated persons. This advantage persists when allowance is made for age, *i.e.*, when the compared groups consist of persons within the same narrow limits of age. The difference remains evident even when the vaccinated persons had, in all probability, been vaccinated only in infancy, many years before the time of the attack. It cannot be explained by differences of social class or nationality.

The amount of homogeneous evidence demonstrating the protective power of vaccination against *attack* is necessarily smaller; in the absence of very special and intensive enquiry which is hardly ever practicable, it can be legitimately objected that the vaccinated and unvaccinated were not known to have been exposed to equal risk of infection. Nevertheless, the cumulative force of the evidence is very great and as has already been said (p. 7) it is for recent vaccination conclusive in the experience of doctors, sick attendants in smallpox hospitals and the staffs of sanitary departments. The evidence cannot be rebutted by citing the errors or exaggerations of those who now, or a century ago, have attributed to vaccination more virtue than it possesses.

But whether so vigorous an enforcement of a legal obligation to vaccinate and re-vaccinate all individuals, as can be carried out in a community under the complex conditions of present-day government, will suffice of itself to secure all needed control of the disease is a different and more doubtful proposition. Reference is made below to the vaccination laws and customs of foreign countries, which go much further in this direction as to re-vaccination, as well as to vaccination, than has ever been the case in England and Wales. The most important consideration for the present review is that in this country the Vaccination Acts from their beginning have never attempted to secure obligatory repeated vaccination of the population so as to maintain them throughout life with a reasonably full protection against smallpox.

## Effect of the present Vaccination Acts principally limited to Infancy Vaccination.

The compulsory requirements of this country have always practically related to infants, although nominally they have extended to requiring the vaccination of older children, *i.e.*, under 14. The Vaccination Acts began at a period when both smallpox and vaccination

were always thought of first in terms of infants and young children. Smallpox in the pre-vaccination epoch was a disease to which the child population was frequently exposed and a very large share of the mortality and fatality from smallpox fell on that section of the community. This has constantly been insisted on in epidemiological literature, notably in the writings of the late Dr. J. C. McVail ; some striking examples of smallpox in pre-vaccination days were given in the Ministry's Report on Smallpox and Vaccination (Public Health and Medical Series, No. 8, 1924).

Vaccination itself was then also thought of principally in terms of the infant. The Jennerian vaccination, and most of the vaccination which continued up to the legislation of 1898 was, for the mass of the population, a system of vaccination of infants from arm to arm, or with human lymph which had been taken in tubes or points from the mature vaccination vesicle of the infant. All the arrangements for public vaccination during this long period rested on measures for collecting infants together so as to enable arm to arm vaccination to be carried on and their lymph to be collected. The use of calf lymph during this period was exceptional. And when the legislation and Order of 1898 substituted calf lymph, and introduced the changes of domiciliary vaccination and the declaration of conscientious objection, the infant under one year remained the chief objective. The compulsory requirements of the Act continued to relate only to children and to primary vaccination. It was true that the Royal Commission on Vaccination had recognised and urged the need of repeated vaccinations to protect the individual against smallpox through life, but it had not recommended any extension of the compulsory system to provide for re-vaccinations, and none was furnished by the legislation of 1898.

The same position practically obtains at the present day. Under the present Vaccination Acts the Vaccination Officer can institute proceedings in respect of any child under the age of 14 for whom he is not in possession of a certificate of successful vaccination, of postponement, or of conscientious objection, and many years ago, in districts in which the Acts were very thoroughly enforced, he sometimes took very considerable trouble in tracing the few older children who were unaccounted for in his books. But this now rarely happens, and for all practical purposes any execution of the compulsory clauses of the Vaccination Acts is limited to infants under 1 or at most under 2 years of age, the procedure taken in these cases being under Section 29 or Section 31 of the Vaccination Act, 1867.*

The following table relates to officially recorded vaccinations in England and Wales. Although in the third column the figures for " Vaccinated " are not exclusively vaccinations of infants, they are made up almost entirely of vaccinations at that age, i.e., so far as this can be judged by comparison with the returns made to the Government Lymph Establishment.

* For a fuller statement of the statutory position, *vide* L.G. Act Memorandum No 33 .issued by the Ministry of Health in January, 1930.

ENGLAND AND WALES.—OBSERVANCE OF THE VACCINATION LAWS IN 1898 AND IN SUBSEQUENT YEARS.

| Year. | Births. | Vaccinated. | Percentage of Vaccination to Births. | Insusceptible. | Had Small-pox. | Exempted. | Died. | Postponed. | Remaining. | Not accounted for (including Cases postponed), Percentage of Births. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1898 | 923,059 | 562,059 | 61·0 | 3,232 | 4 | 47,423 | 110,912 | 16,921 | 181,830 | 21·5 |
| | | | The Vacc | ination Act, | 1898, came | into operati | on on 1st Ja | nuary, 1899. | | |
| 1899 | 929,189 | 617,113 | 66·4 | 5,379 | 4 | 33,573 | 113,516 | 16,605 | 142,999 | 17·2 |
| 1900 | 927,222 | 636,940 | 68·7 | 2,261 | 2 | 39,699 | 103,538 | 14,225 | 130,557 | 15·6 |
| 1901 | 929,882 | 664,366 | 71·4 | 2,631 | 27 | 39,925 | 102,007 | 12,317 | 108,609 | 13·0 |
| 1902 | 940,509 | 703,721 | 74·8 | 3,027 | 27 | 33,759 | 90,826 | 12,213 | 96,936 | 11·6 |
| 1903 | 948,383 | 714,637 | 75·4 | 2,573 | 17 | 37,675 | 91,754 | 12,489 | 89,238 | 10·7 |
| 1904 | 945,500 | 711,504 | 75·3 | 2,676 | 22 | 40,461 | 94,686 | 12,723 | 83,428 | 10·2 |
| 1905 | 929,540 | 705,040 | 75·8 | 2,252 | 8 | 44,369 | 84,712 | 13,175 | 79,984 | 10·0 |
| 1906 | 935,338 | 686,992 | 73·4 | 2,203 | 6 | 53,828 | 88,553 | 14,376 | 89,380 | 11·1 |
| 1907 | 918,341 | 651,050 | 70·9 | 1,926 | 1 | 76,709 | 78,513 | 14,916 | 95,226 | 12·0 |
| | | | The Vacc | ination Act, | 1907, came | into operati | on on 1st Ja | nuary, 1908. | | |
| 1908 | 940,640 | 594,792 | 63·2 | 2,438 | 2 | 160,350 | 80,188 | 14,333 | 88,537 | 10·9 |
| 1909 | 914,844 | 547,279 | 59·8 | 2,280 | 1 | 197,342 | 70,388 | 13,919 | 83,635 | 10·7 |
| 1910 | 897,273 | 501,638 | 55·9 | 1,592 | 0 | 233,677 | 67,768 | 12,702 | 79,896 | 10·3 |
| 1911 | 881,159 | 460,598 | 52·3 | 2,492 | 0 | 250,798 | 75,066 | 12,053 | 80,152 | 10·5 |
| 1912 | 872,799 | 436,951 | 50·1 | 1,367 | 0 | 280,529 | 60,238 | 12,552 | 81,162 | 10·7 |
| 1913 | 882,261 | 410,094 | 46·5 | 1,003 | 1 | 310,717 | 67,141 | 12,705 | 80,600 | 10·6 |
| 1914 | 878,901 | 381,690 | 44·6 | 1,453 | 1 | 320,421 | 65,626 | 13,426 | 86,284 | 11·3 |
| 1915 | 814,825 | 370,763 | 45·5 | 836 | 4 | 291,787 | 57,184 | 13,244 | 81,007 | 11·6 |
| 1916 | 785,397 | 350,975 | 44·7 | 1,200 | 0 | 290,515 | 51,582 | 12,910 | 78,215 | 11·6 |
| 1917 | 668,815 | 289,917 | 43·3 | 1,114 | 1 | 253,291 | 44,249 | 10,837 | 69,406 | 12·0 |
| 1918 | 662,900 | 274,880 | 41·5 | 1,420 | 1 | 248,885 | 44,693 | 11,760 | 81,261 | 14·0 |
| 1919 | 693,090 | 281,413 | 40·6 | 1,059 | 2 | 278,660 | 44,163 | 12,304 | 75,489 | 12·7 |
| 1920 | 958,568 | 378,414 | 39·5 | 1,643 | 2 | 416,306 | 55,295 | 14,691 | 92,217 | 11·2 |
| 1921 | 849,060 | 324,864 | 38·3 | 1,325 | 3 | 382,157 | 49,981 | 11,124 | 79,606 | 10·7 |
| 1922 | 780,277 | 314,550 | 40·3 | 1,162 | 4 | 347,511 | 41,778 | 9,329 | 65,943 | 9·6 |
| 1923 | 758,404 | 362,851 | 47·8 | 1,541 | 11 | 280,252 | 39,374 | 9,771 | 64,604 | 9·8 |
| 1924 | 730,205 | 346,650 | 47·5 | 1,516 | 7 | 271,176 | 39,370 | 10,130 | 61,356 | 9·8 |
| 1925 | 710,400 | 314,325 | 44·2 | 1,388 | 11 | 292,409 | 37,864 | 9,235 | 55,160 | 9·1 |
| 1926 | 694,859 | 311,142 | 44·8 | 1,839 | 39 | 284,122 | 35,627 | 8,435 | 53,655 | 8·9 |
| 1927 | 654,431 | 293,954 | 44·9 | 1,585 | 30 | 266,668 | 31,905 | 8,105 | 52,184 | 9·2 |
| 1928 | 660,271 | 281,417 | 42·6 | 1,655 | 18 | 280,815 | 32,884 | 8,345 | 55,137 | 9·6 |

If, as has often happened, the prevalence of smallpox in a district has occasioned a large resort to public and private vaccination among older children and adults, this must be regarded as only incidentally connected with Vaccination Act administration. The additional vaccination practised in these circumstances is of a kind which is either voluntarily sought for or accepted, or has been urged on the population by the medical officer of health and public health authorities, not as a Vaccination Act measure but one which, if the vaccination had not been done by public vaccinators under the Vaccination Acts, would certainly have been provided by the public health authorities in some other way for the prevention of smallpox.

## Local Variations in the Acceptance of Infancy Vaccination.

Great differences obtain between different parts of the country in the extent to which parents habitually accept for their infants the vaccination which is required by the Vaccination Acts in the absence of conscientious objection or other sufficient reason. Illustrations of this were furnished year by year in the Annual Reports of the Medical Officer of the Local Government Board and have been continued in those of the Chief Medical Officer of the Ministry of Health. The Annual Report of the Medical Officer of the Local Government Board for 1901–2 gave a statistical statement regarding the administration of the Vaccination Acts in England and Wales during the 28 years 1873–1900, illustrated by maps showing the growth and the characteristic localisation to certain counties of what was termed "abstention from vaccination." Among the counties showing the highest rates of abstention in 1900 were Bedford, Derby, Leicester, Northampton and Gloucester. The later returns from these counties show that they have maintained their position in this respect.

PERCENTAGES OF BIRTHS UNVACCINATED.

| — | 1900. | 1909. | 1912. | 1921. | 1928. |
|---|---|---|---|---|---|
| Co. Bedford .. .. .. | 59·6 | 71·2 | 77·6 | 90·2 | 90·1 |
| Co. Derby .. .. .. | 36·6 | 54·7 | 67·5 | 86·9 | 78·1 |
| Co. Leicester .. .. | 64·6 | 75·6 | 82·7 | 84·6 | 80·7 |
| Co. Northampton .. .. | 55·7 | 64·3 | 71·7 | 88·1 | 85·0 |
| Co. Gloucester .. .. | 34·7 | 45·3 | 59·5 | 81·9 | 81·4 |
| ENGLAND AND WALES .. | 19·9 | 32·3 | 42·8 | 55·7 | 52·1 |

For practical purposes they may be considered not merely as counties in which infants are habitually unvaccinated so far as the Vaccination Acts are concerned, but as areas where a considerable majority of the younger adult population—that under 20 or even

under 30—was not vaccinated in infancy.* But yet these counties, though selected as having for the longest period accepted the smallest amount of infantile vaccination, have not, individually or as a whole, been the counties which have suffered most conspicuously from variola major ; and while, during the recent epidemic years of variola minor, some of them (e.g. Derbyshire) have been counties of considerable prevalence, others (Northampton, Bedford) have not. The geographical distribution of variola minor in England has certainly not been determined mainly by the local acceptance of infantile vaccination ; other and more important influences have predominated. In so far as the absence of habitual infancy vaccination placed some areas at a disadvantage, this drawback has usually been sufficiently concealed or compensated for by the action of the public health authorities in the various directions mentioned in Part I. of this review, *i.e.*, use of notification, hospital isolation, vaccination of contacts and other measures taken on the emergence of smallpox in the county. And the recent variola minor has also occurred and has been maintained in counties (e.g. Durham, Cheshire) in which the percentage of infants vaccinated under the Vaccination Acts has been much nearer to the average.

## Advantages, in the Control of Smallpox, of the Infancy Vaccination provided by the Vaccination Acts.

If an attempt be here made to summarise the advantages of the infancy vaccination provided in England and Wales under the Vaccination Acts, emphasis may be placed on the three following points :—

(*a*) To the extent to which it is accepted in a district (an acceptance which may vary from little more than zero to some 60 or 70 per cent.), the vaccination thus obtained places a section of the population, roughly those under ten years, in possession of very considerable immunity against risk of attack from smallpox when exposed to that infection. Taking children under ten as constituting some 18 per cent. of the general population, then under the mose favourable conditions of general acceptance of infancy vaccination (allowing that is to say only for deaths before vaccination and the cases in which vaccination was postponed for reasons of ill-health) ont would have somewhere about 15 per cent. of the population with this considerable immunity. In an anti-vaccination area in which declarations of conscientious objection are numerous, or in which the administration of the Vaccination Acts has fallen into disuse, this proportion would be almost nothing. Intermediate between the two would be, say, an average county in which about 40 per cent. of the infants are vaccinated and the proportion of the total population

* It is true that to a variable extent in these counties a proportion of the younger adult population may have been vaccinated at some period or another on account of prevalent smallpox or of army service, but this is beside the present argument.

possessing this considerable immunity would be in the region of, say, 9 per cent.

That this degree of immunity where it exists may be of material consequence during the prevalence of an epidemic will be admitted, particularly on consideration of the history of last century when smallpox was uncontrolled and spread among the unvaccinated in the schools—the case of Gloucester in 1895 has already been referred to. Another example of its value is suggested by study of any of the tables which have been given in the Annual Reports of the Chief Medical Officer showing the distribution of the total notified smallpox cases in England and Wales according to age and according to vaccinal state.

The table for 1927 is attached as an example :—

ENGLAND AND WALES : VACCINAL CONDITION OF CASES OF SMALLPOX OCCURRING DURING 1927.

| Ages. | Vaccinal Condition at time of infection. | | | |
|---|---|---|---|---|
| | A | B | C | D |
| | Successfully vaccinated. | Successfully revaccinated. | Unvaccinated | Doubtful. |
| Under 1 year .. | — | — | 174 | — |
| 1— .. .. | — | — | 122 | — |
| 2— .. .. | — | — | 187 | — |
| 3— .. .. | — | — | 218 | — |
| 4— .. .. | — | — | 294 | — |
| 5— .. .. | 1* | — | 442 | 1 |
| 6— .. .. | — | — | 530 | — |
| 7— .. .. | 1† | — | 613 | — |
| 8— .. .. | 1 | — | 462 | 1 |
| 9— .. .. | 1 | — | 455 | 2 |
| 10— .. .. | — | — | 455 | 1 |
| 11— .. .. | 4 | — | 449 | — |
| 12— .. .. | 4 | — | 538 | 2 |
| 13— .. .. | 9 | — | 568 | 1 |
| 14— .. .. | 5 | — | 506 | 2 |
| 15— .. .. | 95 | — | 2,120 | 10 |
| 20— .. .. | 151 | — | 709 | 7 |
| 25— .. .. | 149 | 1 | 472 | 3 |
| 30— .. .. | 214 | 2 | 288 | 11 |
| 35— .. .. | 286 | 11 | 231 | 6 |
| 40— .. .. | 933 | 10 | 263 | 24 |
| 50— .. .. | 994 | 9 | 187 | 29 |
| 60— .. .. | 409 | 4 | 69 | 8 |
| 70— .. .. | 82 | 4 | 26 | 8 |
| 80 and upwards .. | 9 | — | 3 | — |
| Totals .. | 3,348 | 41 | 10,381 | 116 |

* This case was seen by a Medical Officer of the Ministry, who did not regard it as one of Smallpox.

† The diagnosis in this case was doubtful.

It has been the general rule in these annual tables to find an almost complete absence of any smallpox cases in vaccinated children under 10, a fact sufficiently significant by itself even though no reliable calculations can be made of the proportion of vaccinated children under ten who were exposed to risk of smallpox infection, to contrast with unvaccinated children of corresponding ages.

(*b*) The population vaccinated in infancy through the operation of the Vaccination Acts will not only possess considerable immunity against attack of smallpox if exposed to it within, say, 10 years, but a much more durable protection, which may last perhaps through life, against severity of the disease or against death from it. This advantage is one, of course, which is only material if the future exposure to infection is that of variola major ; the consideration is of relatively less consequence in regard to variola minor.

(*c*) The vaccinated infant has the further advantage that it is in a better position to remain protected from all varieties of smallpox by repeated vaccinations throughout the rest of its life. A re-vaccination of a person well vaccinated in infancy is ordinarily less likely to be troublesome than the primary vaccination of an adolescent or an adult, and one conspicuous and considerable advantage in this respect has been brought out above, in connection with post-vaccinal encephalitis.

These considerations, (*a*), (*b*) and (*c*), form sound medical grounds for advising the vaccination of infants in the interests of the individual child (both in its childhood and subsequently), for reducing the total amount of variola in childhood and the number of foci of infection thus created, and for laying a foundation of a wider immunity among the people as a whole.

The position in foreign countries is different, in some cases very greatly so, on account of the more complete nature of their vaccination requirements and customs. It is, however, essential to enquire what lessons can be learned from them and a few considerations regarding some of the more important countries have been noted in the Appendix to this review. In particular, attention is drawn in the Appendix to the German system in which the reliance placed upon repeated vaccinations of the whole population, if it has not succeeded in abolishing smallpox, nevertheless has enabled the public health authorities to treat this disease in a different way in regard to the provision of other preventive measures from that which it is necessary to maintain in this country.

As far as administration in England and Wales is concerned, it may be assumed as a practical matter that no further attempts to secure a greater degree of general protection by compulsory provision on the lines of our Vaccination Acts or on the lines of the compulsory vaccination laws of Germany or other European countries are feasible. The effort, with all its difficulties from the side of public opinion, would only be worth making if existing measures for the prevention

of variola major had been demonstrated to be ineffective, or if the risk of importation of that disease were for some reason or other to become far greater than there is any reason to anticipate. The economic side is doubtless important and possibly a considerable amount of money might in theory be saved by putting more into vaccination and less into other measures. But for this result it would have to be assumed that the further compulsory requirements would be accepted, and even then time would have to be allowed for the new requirements to become operative. Moreover, our smallpox hospitals are there, while the means for controlling smallpox, described in Part I. above, are part of the common knowledge and equipment of every public health authority and its medical officer of health. If our system of control is insular or uneconomical, it has at any rate justified itself in practice. In any event, it is quite certain that no augmentation of the amount of compulsion at present imposed by the Acts would be accepted or could seriously be proposed, merely as a safeguard against variola minor.

The most fruitful application to our own circumstances of the lessons to be learnt from other countries (Germany, or, still more, the Latin nations) in this matter would seem to be by using them to popularise the understanding of the purposes of vaccination, and the frequency with which it should be performed, in order to secure a greater increase in the general protection, quite apart from compulsory action of any sort.

It must be admitted, however, that this arrangement will not make any great headway until progress has been made with the studies which are now being pursued into the nature and effects of vaccination, and the means by which we can, it is hoped speedily, vaccinate in such a way that any serious risk of post-vaccinal encephalitis becomes non-existent. But this is a position which may quite well soon be reached. It may be possible to fortify it by clear evidence that vaccination performed with the small dosage which is now being adopted, and repeated sufficiently often, will secure the individual the desired immunity against any variety of smallpox throughout life without on any occasion causing him trouble or risk that is worth a moment's consideration.

### Other Advantages derivable from the Vaccination Acts.

Certain other questions which bear on the advantage of the Vaccination Acts to local authorities, from the point of view of smallpox prevention, also require notice.

*The public vaccinator.*—During the prevalence of smallpox, the chief agent provided by the Vaccination Acts is the public vaccinator, The Vaccination Acts secure that every part of the country has its local public vaccinator, as well as a vaccination officer whose duties are to receive lists of all children born, to account for them in his books, in one way or another, in regard to vaccination, and to send

to the public vaccinator the names of all infants whose parents have not expressed their conscientious objection to vaccination. There are some 1,300 vaccination officers, and the public vaccinators (medical practitioners who hold their appointments in nearly all cases under contracts terminable at a month's notice), number some 3,400. Under this system an infant unvaccinated at the age of four months, in respect of whom there is no exemption under the conscience clause, receives a visit from the public vaccinator, who is required to offer to the parents its vaccination free of cost, using glycerinated calf lymph, or such other lymph as may be issued by the Ministry of Health. The public vaccinator is also responsible for the treatment of the vaccinated arm and inspection within the necessary period, and attention in the case of any unsatisfactory results.

*Government lymph.*—It is thus inherent in the system that vaccination at the public expense should be done by a limited number of medical practitioners under definite obligations of contract, and with a vaccine lymph which is maintained at a satisfactory standard of purity and is properly used. The limitation is advantageous, as it is easier, when a relatively small number of doctors with special experience are concerned, to secure that records are kept on prescribed forms, and to send out lymph supplies regularly from the Government Lymph Establishment.* The returns supplied by the public vaccinators as a matter of routine are of the greatest value to that Establishment in assessing the results of the particular batches of lymph sent out, and in general it may be said that the 3,400 public vaccinators form a body of practitioners familiar with the practice of vaccination, and the requirements of the Vaccination Acts, who realise also the importance of transmission of information regarding any question relating to vaccination to the Government Lymph Establishment or to the Ministry of Health. Central issue and supervision are undoubtedly made easier by this process.

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* The Government Lymph Establishment at The Hyde, Hendon, which was opened in 1907, is the one centre of preparation and supply of glycerinated calf lymph to Public Vaccinators, to the Services and to certain British Colonies, as well as on occasions to Medical Officers of Health.

An account of its operations by the late Dr. F. R. Blaxall, who was the Director of the Establishment from its inception until his death in May last, was given annually in reports of the Chief Medical Officer. An account of the technique and procedure employed at Hendon is set out by the Committee on Vaccination in its Report of 1928 (pages 15 to 17). The total number of tubes, each for a single vaccination, issued for public vaccination (that is, apart from Service and Colonial requirements) in 1927–28 and 1928–29 was 663,317 and 480,990 respectively. A return in respect of every tube issued is required to be made by public vaccinators. A considerable reserve is kept.

Until the Therapeutic Substances Act, 1925, and regulations thereunder, the responsibility of the Ministry of Health for the quality of vaccine lymph was limited to that issued by the Government Lymph Establishment for public vaccination. Control is, however, now exercised over all other lymphs.

*Awards to public vaccinators.*—For a great many years, dating back to the early supervision of the Vaccination Acts by the Medical Department of the Privy Council and in pursuance of the Vaccination Act of 1867, the central department has maintained a system of awards to public vaccinators whose work is reported, or appears to the central department, to be what is termed sufficiently meritorious. This award takes the form of an additional shilling per infant vaccinated, which is paid to the public vaccinator over and above the sums due to him under his contract by the Council of the county or county borough in which he practises. In connection with its distribution it has been the practice for visits of inspection to be made by Medical Officers of the central department to the public vaccinator, at which his vaccination routine is considered and children vaccinated by him are inspected so far as practicable.

In further endeavour to secure that medical practitioners entering into vaccination contracts not only are fully competent to vaccinate, but are acquainted with the main facts regarding vaccination and the administration of the Vaccination Acts, it has been the usual practice for the special course of instruction in vaccination, which is prescribed as part of the medical curriculum of the student before his qualification, to be given by a public vaccinator appointed for the purpose under the authority of the central department. His demonstrations have been designed to familiarise the student with the public vaccination system, official records, forms of certificate and matters of this kind, as well as with vaccination technique.

*Vaccination by the public vaccinator on request.*—A further and very considerable advantage of the present system, perhaps the one which will appeal most to Public Health Authorities, is that the public vaccinator is not under his contract limited to duties of vaccinating infants and children in relation to the obligatory clauses of the Vaccination Acts, but he also undertakes, under his contract, to vaccinate or revaccinate persons of any age who apply to him for the purpose. This is a function which in ordinary non-epidemic times makes relatively small demands on the public vaccinator. He is occasionally asked to vaccinate or revaccinate a person going abroad or entering a service where vaccination is made a condition, but such cases are few. On the other hand, when smallpox is prevalent in a district, the public vaccinator is available not only for any members of the general public who wish to be vaccinated, but also he has been enjoined by numerous circulars of the Local Government Board and the Ministry of Health to put himself into such relations with the Medical Officer of Health of the district as will enable him to visit and vaccinate contacts of smallpox cases and persons suspected of having been exposed to infection. In this process a part is also assigned to the vaccination officer, who has similarly been enjoined, on the appearance of smallpox in a district, to do what is possible to trace children who have so far escaped primary vaccination. The public health authority therefore now has trans-

ferred to it, under the Local Government Act, 1929, a system giving it practically first call on the time of one or more medical practitioners in its area, who are familiar with vaccination, who have supplies of Government lymph, and who may be expected to act promptly in connection with any case of smallpox infection.

## Lessened Value of these Advantages under Present Conditions.

There are very substantial assets derivable from the transfer under the Local Government Act. But it is well to recognise that the different reasons which originally produced the duties which are required of the public vaccinator are less existent to-day, having been affected by changes in methods of vaccinating, altered methods of administration, and other developments.

*Less need for specialising.*—To begin with the expert side of vaccination. The public vaccinator of the last century in the arm-to-arm human lymph period, had necessarily to possess a great deal of rather specialised experience. It was not merely a question of the selection of infants from whom to take lymph, but he needed practical experience of and patience with a complicated system under which from week to week a supply of suitably vaccinated infants could be got to his vaccination station, and the system could thus be made workable for the mothers and infants who attended, in some cases from long distances. When this system was superseded by domiciliary vaccination, and calf lymph was used, the special experience required was less, but nevertheless a certain technique was still specially enjoined by official regulations, notably the production of a sufficient area of vesiculation (not less than $\frac{1}{2}$ sq. inch, obtained by four insertions) and attention to dressings being applied to the vaccinated arms in the way which had been recommended by the Royal Commission on Vaccination, 1889–96. But these items of expert technique are now of less importance. On the recommendation of the Committee on Vaccination, the Ministry of Health has advised that ordinary vaccination should preferably be done by a single insertion without regard to the total area of vesiculation produced. The technique required and described is so simple that it is, and should be, expected of any medical practitioner, whether he has had a large experience of vaccinating or not. Much the same applies to dressings to the arm in these circumstances.

*Anomalies of "award" system.*—On the technical side it is difficult or impossible now to attach any significance to the condition "sufficiently meritorious" which governs the additional Government award above referred to. The award merely recognises the merit, so far as it is one, of entering the names of the children vaccinated and the dates of vaccination and inspection in such a way that the registers, when forwarded to the Ministry for the purposes of examination,

do not disclose any too obvious or frequent errors. The visits of Medical Officers of the Ministry to the public vaccinators for the purposes of the award are now made only at occasional intervals, and, owing to other demands on the medical staff, the former practice by which every public vaccinator in the country was inspected about every two years has been discontinued.

*Medical students and public vaccinator duties.*—Incidentally it may be noted that the necessity for public vaccinators being chosen and appointed to give special courses of instruction to students, outside the ordinary medical curriculum, has sometimes been doubted in recent years. It has been found inconvenient not only in the adjustment of time-tables, but also because of the additional fees which are usually required for the course. Hitherto the teaching of vaccination to medical students has usually been in the hands of a local public vaccinator who has instructed students at the Medical School or elsewhere. Recently exception has been allowed by which this instruction should be given by a competent member of the staff of the Medical School, generally in conjunction with the public vaccinator. This decision was not arrived at without consideration of certain advantages secured by the course being given by the public vaccinator, but on the other hand, it was difficult to resist the claim of the medical schools that vaccination ought to be taught to the student, not as some entirely separate ritual of medicine which required persons of long experience of vaccination to give, but rather that it should be treated in common with other operations and inoculations for immunisation against disease. In this as in other questions the position is materially modified by the advice recently given to public vaccinators to use the one insertion method recommended by the Committee on Vaccination. So long as the theory of infancy vaccination by the public vaccinator was to take the one obligatory opportunity to secure a sufficiently large and lasting response to the vaccine, and to employ a technique which would produce the required area of vaccinated surface, and the requirements were seen to and enjoined by the medical inspectors of the Central Department, it was useful that they should be expounded to the medical student by public vaccinators. The substitution of a smaller dose of vaccine in a single insertion removes some of the need for such exposition and indeed, looked at from a wider viewpoint, now makes the restriction of public vaccination to a selected number of public vaccinators apparently less necessary.

## Some possible Alternatives.

It is already becoming a question of some interest to local authorities and medical officers of health to decide whether those advantages of the system which still remain counterbalance the drawbacks of its rigidity.

If they desire to follow the suggestion of the Committee on Vaccination, the one mark vaccination is a proceeding which should not be taken as an end in itself to comply with the Act of Parliament, but as one which the individual should be advised and assisted to adopt for himself and for his children at several stages of life with the idea of maintaining himself and them at a reasonably high degree of immunity at all times. If this could be secured by efforts on new lines in this country, it would have to be by persuasion and by voluntary acceptance. And in that case it may be argued that little is gained by beginning the system with the rigid forms of the Vaccination Acts in relation only to the vaccination of infants. The machinery which is put in motion under the Acts, beginning at the time of registration of the birth with vaccination forms which are given to parents, going on to the lists of births registered which are transmitted to the vaccination officers, to the inquiries which the latter are required to make, to the notices which they send to the public vaccinator, followed by the formal notices of the public vaccinator of his intention to visit the house, and the different formalities associated with the delivery of certificates or of obtaining exemption on grounds of conscientious objection, may all be necessary enough when a single vaccination is all that can be officially aimed at, but it constitutes a process which it would be out of the question to repeat at later stages of life.

The vaccination register, for which the vaccination officer receives copies of the birth certificate of every child from the Registrar, is an institution dating well back into the last century to a time when no idea was entertained that any public authority would be concerned in other ways with the health of infants. Now that the practice has been established, through the Notification of Births Acts, 1907 and 1915, that the medical officer of health receives notification of births in the district independently of the Registration Acts, local authorities will naturally inquire whether the elaborate separate system of a special register and registrar is necessary solely for vaccination purposes. The local authority has now, in connection with its normal work of infant welfare, a machinery by which parents are visited and inquiries made in regard to the welfare of their infants. It is customary to give advice to mothers, which is almost universally welcomed, on matters of clothing, feeding and general care of the infant, and it is evident that on the basis of endeavouring to secure voluntary acceptance of vaccination it should much more easily be secured by the use of this normal public health agency. As the Committee on Vaccination pointed out, to do so would no longer mean that public vaccination of infants can only be performed at the homes. Public vaccinators, if they were retained as a separate class of medical practitioners for this purpose, would vaccinate as officers of the Health Department and under the direction of the Medical Officer of Health on lists supplied to them by the latter.

Arrangements on these lines for securing the voluntary acceptance

of vaccination, on the theory of the Committee, might, if parents so desired, be accompanied by corresponding arrangements during school age effected through the service of medical inspection of school children, although pending further knowledge as to the means of avoiding all risk from post-vaccinal encephalitis, it would still be necessary for the present not to press vaccination in the case of school children who had escaped primary vaccination in infancy.

Use might be made of the numerous occasions on which public health authorities now in one way or another advise or influence adult communities on health questions, to secure further renewal of their vaccinal protection. It is difficult to envisage any one plan by which efforts on this basis could be made most successful or fruitful. It would necessarily depend upon local initiative and local circumstances, but this after all is the essence of our system of local government. It may be claimed that an authority which desired to promote vaccination through its public health department on some such lines would at least succeed in producing a more satisfactory effect as regards protection of its population by systematic vaccination than it could obtain by the strictest application of the obligatory clauses of the Vaccination Acts.

There remains the question of the usefulness to the public health authority of having a number of public vaccinators ready to vaccinate persons of any age on application or to visit houses for the purposes of vaccination during an epidemic period. So far as it is necessary to have definite arrangements for this purpose fixed in advance, this present obligation of public vaccinators is no doubt an advantage, but it would appear to be one which could be obtained by local arrangements in other ways without any necessity of utilising the Vaccination Acts machinery. The latter is in some respects somewhat too rigid to be satisfactory for the prompt vaccination which is needed in epidemic periods. The public vaccinator by his contract is limited to a particular territorial area (in the larger cities sometimes quite arbitrarily defined and not corresponding to any natural or convenient boundary) and ordinarily obtains no fees under his contract in respect of persons who may apply to him or persons whom he may be asked to vaccinate on account of smallpox, if they do not reside within his area. Insistence on this territorial requirement might cause undesirable delay in vaccinating or result in no vaccination being done. If the public health authority decide to entrust the duty of vaccinating in epidemic periods in advance to certain practitioners, in addition to its own public health officers, it would certainly find it convenient to use them for vaccination in any part of the district.

If the above lines of development were pursued they would, of course, rest on the assumption that the supply of vaccine lymph from the Government Lymph Establishment would be issued to Medical Officers of Health in much the same way as it is at present to the different public vaccinators, though no doubt for county areas

supplementary arrangements would have to be made for direct supply to different parts of the county under the authority of the Medical Officer of Health. The latter would have to undertake the duties of collecting and forwarding records that are essential for the purpose of checking the quality of the vaccine lymph distributed, and they would also be responsible for transmitting to the central authority information regarding any unusual results of vaccination or complications which might require investigation.

These are questions, suggestions and alternatives which, it is submitted, should now receive the consideration of the medical advisers of the Local Authorities to whom have been transferred the duties of providing for the effective public vaccination of the community.

## IV.

## SUMMARY.

This review touches on a large number of questions, themselves many-sided, and the only useful summary which can be attempted is a note of those which seem to call for present consideration from a practical and administrative standpoint.

1. England and Wales remains, as it has for the last half century, intrinsically more vulnerable to the serious and rapid spread of severe epidemic smallpox than are European countries like France and Germany, where the population is immunised compulsorily against smallpox by repeated vaccinations at two, three or more age periods. On the other hand the protective methods which are part of ordinary English administration, and include vaccination, have proved themselves on many occasions sufficient to prevent the development of epidemic severe smallpox when introduced, either by extinguishing it at the start, or by circumscribing the local epidemic which occurs and ultimately getting the community free of the results of the invasion. There is no reason to expect that this will not be as efficacious in future as in the past. It demands vigilance not only from the local health authority, but also from the central authority, which has to treat severe (Eastern or major) smallpox in the same way as other exotic diseases like plague, cholera, or typhus from the point of view of surveillance and intelligence work, if it is to be extinguished. There is no difficulty in this. There are, however, certain modifications of the ordinary procedure of local authorities in a district invaded by variola minor which should be considered : these are mentioned on pages 29 *et seq.*

2. Variola minor can usually be effectively and speedily extinguished, on its first appearance in a district, by the same methods as those applicable to variola major, though in this respect, also, certain modifications of the ordinary procedure deserve attention.

3. If variola minor has taken hold in a district, its immediate extinction by administrative action designed for variola major may become a matter which would require efforts and expenditure that are too great to be expected in practice, and would indeed hardly be desirable even if they were practicable. The only workable procedure is to keep the disease under a reasonable degree of control, relying on its low infectivity and tendency to die out from an area in a few years. Such practicable control, in addition to insistence on prompt notification and provision of aid in diagnosis, includes hospital isolation, the tracing of direct contacts and offers of vaccination to them ; and popular and unbiassed education of the population on the safeguards which the individual can obtain by

vaccination against any variety of smallpox, and on the way in which he can obtain a vaccination with the minimum of inconvenience and risk.

4. It has to be recognised that in this country at the present time it would be quite impracticable to secure a population so sufficiently and frequently vaccinated that all other measures against smallpox of any variety would be redundant or unnecessary. Further, it may be found by Public Health Authorities, after some experience of the administration of the Vaccination Acts, that in endeavouring to cope with smallpox by securing general vaccination they derive little advantage from those Acts that could not be obtained more satisfactorily if the Acts were replaced by voluntary measures, such as are mentioned in Part III of this Review. One of the objects of the Review is to suggest to these Authorities and their Medical Officers of Health that they should observe the working of the Vaccination Acts under the new conditions which have operated since the 1st April last, and in the light of their experience formulate such proposals as may seem to them desirable for facilitating the general acceptance of vaccination in infancy and afterwards, and for preventing the spread of smallpox.

Ministry of Health,
Whitehall,

*March*, 1931.

# APPENDIX.

## Note on Vaccination Requirements in certain European Countries.

Several references have been made in this review to the practice of European countries in respect of obligatory systematic vaccination of their populations. Their practice is by no means uniform and, as in England, they represent the results of various pieces of ancient and modern legislation and administration adopted from time to time in the light of current conceptions of smallpox, and of the administration which then seemed desirable or practicable. *Sweden* represents, for example, a country in which, like our own, the obligatory requirement is only for a primary vaccination which has to be performed at latest before the child reaches 6 years. The *Norwegian* vaccination law dates back to 1810 and, directly or indirectly, requires the individual of any age to be provided with evidence that at some period or other he has been vaccinated. In practice the large bulk of the vaccinations for this purpose are carried out in infancy.

In *Holland* for a great many years (since 1872), evidence of primary vaccination has been required at the time a child begins to go to school, and in consequence, the great bulk of vaccinations have been performed at the younger school ages. The selection of school age for obligatory vaccination has the advantage of practically eliminating the possibility of any wholesale spread of smallpox in schools and a further advantage that the protection thus conferred both against attack and severity is carried considerably further into adult life than is the case with the vaccination of the infant. It may be noted, however, that the general primary vaccination of the population at this age, while no doubt protecting a considerable part of the population, is not regarded as in any way a sufficient safeguard by itself on the appearance of smallpox in the country. In 1929 when smallpox was introduced into Rotterdam and spread to other parts of Holland, it was decided (see page 41,) to promote a mass vaccination of the population of the regions affected irrespective of the normal compulsory obligation for the child at school. The recent realisation of post-vaccinal encephalitis as a complication specially liable to occur in the primary vaccination of children of school age has moreover now made continuation of this practice difficult in Holland, and the ordinances under which it is required have been in abeyance since 1st January, 1928.

In other countries the basis of legislation and practice is the definite attempt to secure that the whole population is maintained throughout life, or in any case from infancy well into adult life, in a state of immunity. In other words, the obligation is not only for vacinating in infancy but for a second, and perhaps a third vaccination at later ages. The second vaccination is usually required

at the school ages, and the third for the men at the time of military service.

Among the countries of Europe which have formed or reorganised their health services since the war, this plan has been adopted, for example, in the case of *Poland* (vaccination of infants under 1 and of school children at the age of 7). In *Bulgaria* under the recent public health legislation, obligatory primary vaccination is at the end of the first year of life, followed by a first re-vaccination on going to school and a second re-vaccination at the age of 21. Similarly in *Yugoslavia* the primary vaccination required of all infants under 1 is followed by an obligation for the vaccination of all children on reaching the 4th class of the Normal School as well as of apprentices, students of technical schools, etc.

In the *Union of the Soviet Socialist Republics* the law of October, 1924, makes three vaccinations compulsory for the whole population —one first vaccination during the first year after birth and two successive vaccinations at the age of 10 or 11 and at the age of 20 or 21. The amount of vaccination carried out in the U.S.S.R. since that date is stated to have been in the region of seven millions annually, and to have been accompanied by a very conspicuous diminution in the occurrence of smallpox.

In *France*, Article 6 of the Law of February 15th, 1902, renders anti-smallpox vaccination compulsory ; it must be effected during the first year of life, with re-vaccinations during the eleventh and twenty-first years of life. The Decree of July 27th, 1903 (published in the Journal Official, July 31st, 1903), the Ministerial Circular of August 7th, 1903, and the Ministerial Order of March 28th, 1904, enumerate the requirements in considerable detail. In addition, special regulations, including provisions for compulsory vaccination, are applicable in local areas in which smallpox has appeared, provisions which it is understood are of special importance in France in view of the frequency with which variola major is liable to be imported from Northern Africa.

In *Italy*, the laws since 1888 have required obligatory vaccination within six months of birth, at school age and finally at military service age. At the present time, on this system, the total annual vaccinations in Italy are reckoned at between one and two millions. Since 1900 there have been definite epidemic periods of severe smallpox in Italy, from 1901-4, and in 1911-12 ; and during the war, especially in 1916 and 1917, there were other outbreaks of smallpox in the country, attributed to unusual conditions and particularly to the absence on military service of doctors who normally would have vaccinated. Since then, with the exception of a very small number of cases in 1925-6, the country has been free from smallpox.

In *Roumania* vaccination and revaccination are required in the first few months after birth, on entering elementary schools, and on enlisting. The adoption of general revaccination of the population more or less on these lines began before the middle of last century,

and they were in operation in the population at the time of one of the principal smallpox epidemics of the late war, *i.e.* that of the years 1914 to 1919, during which time infection was frequently introduced by refugees and by invading armies. Its practical disappearance since 1922 is attributed not merely to the systematic vaccination at the ages mentioned but also to the mass vaccination on a considerable scale which resulted from the epidemic period of 1914-19.

It may be noted as apparently more characteristic of the Latin countries than of the other countries of Europe that the primary vaccinations and revaccinations seem to be accepted with little objection by the people, who ordinarily regard them as a normal procedure for the good citizen to carry out for himself or his family :— with the result that the legislative or administrative provisions for enforcement of vaccination are seldom much in evidence or even applied. Illustration of this is afforded by the different position of vaccination in Switzerland as between the French and Italian Cantons on the one hand and the German Cantons on the other.

The country usually quoted as the best example of continued protection of the whole population by vaccination and revaccination, thoroughly enforced by the authorities concerned, is *Germany*, where according to the legislation of 1874 and as now applied under official instructions of 1917, vaccination is required in respect of (1) every infant under the age of 1 year and (2) every child attending a public or private school in the course of his twelfth year. Until the war the requirement of a fresh vaccination was part of the obligation of general military service. For the last period for which data are available (1921 to 1925) between 1,000,000 and 1,500,000 primary vaccinations per annum have been carried out in Germany, while the number of revaccinations of children has ranged from 1,300,000 to 1,400,000. It is reckoned that about 85 per cent. of infants are primarily vaccinated, while revaccination is the almost universal practice. The contrast between the degree of general protection given by vaccination in Germany and in England is thus striking, and it is no doubt the fact that the German advantage in this respect is responsible, more than any other factor, for the absence in normal German health administration of the elaborate provisions and procedures which have come to be adopted in England to meet epidemics of smallpox side by side with the protection obtained under our vaccination laws. It has been considered practically unnecessary in Germany, for example, to provide special hospitals for smallpox and the demand for hospital accommodation at infectious diseases hospitals or general hospitals in Germany has always been comparatively small in the case of smallpox,—a consideration of considerable economic advantage. This, no doubt, creates a difficulty in making any clear-cut comparison between England and Germany in the matter of smallpox prevalence, since in our own country a spread of the disease which might be expected from our inferiority in the matter of systematic vaccination, is so very largely counterbalanced

by the efficacy of the concurrent measures of notification, isolation and tracing of contacts. If variola major is alone in question, it could be maintained that the English methods, if vigorously and effectively pursued, produce no worse result in regard to prevalence of smallpox than the German reliance on general protection. Even the latter has not always prevented the spread of smallpox in exceptional circumstances, for example, during the post-war years. This will be seen from the table of deaths below.

Subject to the above important reservations, it is interesting to note that in the period covered by the annexed table Germany with a population half as large again as England and Wales has suffered little more than half the mortality from smallpox that we have had.

## TABLE III.

DEATHS FROM SMALLPOX IN ENGLAND AND WALES AND IN GERMANY, 1900–1929.

| Year. | England and Wales. | Germany. |
|---|---|---|
| 1900 | 85 | 49 |
| 1901 | 356 | 52 |
| 1902 | 2,464 | 12 |
| 1903 | 760 | 18 |
| 1904 | 507 | 25 |
| 1905 | 116 | 27 |
| 1906 | 21 | 47 |
| 1907 | 10 | 63 |
| 1908 | 12 | 65 |
| 1909 | 21 | 23 |
| 1910 | 19 | 34 |
| 1911 | 23 | 37 |
| 1912 | 9 | 35 |
| 1913 | 10 | 12 |
| 1914 | 4 | 19 |
| 1915 | 13 | 20 |
| 1916 | 18 | 91 |
| 1917 | 3 | 448 |
| 1918 | 2 | 60 |
| 1919 | 28 | 704 |
| 1920 | 30 | 332 |
| 1921 | 5 | 109 |
| 1922 | 27 | 26 |
| 1923 | 7 | 10 |
| 1924 | 13 | 6 |
| 1925 | 9 | 9 |
| 1926 | 18 | 0 |
| 1927 | 47 | 1 |
| 1928 | 53 | 0 |
| 1929 | 39 | 0 |

It may be argued that the heavy English mortality is confined to the first few years of the century, and that we cannot prove that the vaccinal state of Germany was the sole cause of the failure of the epidemic of 1901–2 to develop there; vaccination did not prevent the emergence of local epidemics in the unfavourable conditions of the war years. On the other side, it might be urged that the good vaccinal state of the German population may have limited the mortality in these epidemic years, which at least compares favourably with that of the epidemic years 1901–3 in England and Wales.

It seems fair to infer from the evidence as a whole (1) that the better vaccinated nation has had to pay a lighter toll, although the current risks of infection were probably at least as great as in England and Wales, but (2) that a more stringent enforcement of vaccination laws than one can expect to realise elsewhere has not sufficed always to eliminate smallpox from the country. It is noteworthy, moreover, that certain resistance to compulsory requirements of vaccination is showing itself in Germany, and that modifications of the vaccination laws so as to eliminate police action and take account of conscientious objection are now under consideration by the German health authorities (*v.* Reichsgesundheitsblatt A p. 2, 1930, Vol. V., 14, p. 238.)

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