

# THE PROBLEM OF THE DIPHTHERIA CARRIER IN LONDON CHILDREN OF SCHOOL AGE.

BY

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The high prevalence of diphtheria in London during the past three years, 1920 to 1922, has surpassed all previous records, and for anything approaching it one must go back to the eight years' period between 1893 and 1901.

It follows on a long spell of sixteen years' comparative freedom, from occurrence of the disease in epidemic form, during 1903 to 1918, when its incidence was with but trifling exception below the mean.

The storm of infection may be said to have arisen in the last half of 1919, to have reached its height in the final quarter of 1921, and to have diminished but little in 1922.

During 1918, the 8,173 cases notified exceeded the mean of 7,760 for the previous ten years, 1908 to 1917. The increase in notification in 1919 to 9,459 was concentrated in the last quarter of that year, and was succeeded by further rises, in 1920 to 13,780, in 1921 to 16,319, which unprecedented maximum was only slightly reduced in 1922 to 15,287.

This abnormal prevalence has shown an annual rise in late autumn, with a corresponding fall in early summer, and may therefore be described as a succession of waves, each crest higher than the last, each trough well above the ten years' mean. The general increase during this period, has, as might be expected, fallen heavily on our schools and is represented by the growing number of cases notified each year in the school-age period of 5-15 years. In 1918, 4146; 1919, 5293; 1920, 6499; 1921, 9089; and in 1922, 7352.\*

With the object of checking this heavy toll and for the prevention of further spread in the schools, special visits of investigation for diphtheria alone were paid to 317 elementary schools in 1920. During 1921 no fewer than 281 investigations took place in the schools situated in the 29 various metropolitan boroughs, but mainly, in the N.W., in Hampstead; in the N.E., in Islington and Hackney; in the E., in Stepney; in the S.E., in Bermondsey, Lewisham and Woolwich; and in the S.W., in Battersea and Wandsworth. In 1922, 259 special visits were paid to schools in

\* Chart VII. for monthly diphtheria rate and carrier rate in schools (1921 and 1922). See Chart VIII. for monthly diphtheria rate 1921 and 1922; and mortality case rate (ages 5-15).

each of these boroughs, but more particularly in Islington, Bermondsey, Greenwich, Southwark, Battersea and Wandsworth.†

The following explanatory notes refer to the accompanying charts which are spaced into periods of four quarters for each of the two years (1921 and 1922):—

CHARTS I. TO V. (pp. 3-7).

Charts arranged in divisions showing the diphtheria incidence for all ages *per 10,000 population* in each of the 29 Metropolitan Boroughs for each quarter of 1921 and 1922, and, for corresponding periods in the columns below, the diphtheria carrier rate *per cent.* as found in children swabbed in affected schools in each Borough.

CHART VI. (p. 10).

Composite chart of each of the five divisions showing (1) diphtheria incidence for each quarter *per 10,000 population*, (2) school carrier rate *per cent.* of children swabbed, (3) percentage proportions of virulent to avirulent among carriers from whom the diphtheria bacillus was isolated and tested for virulence.

CHART VII. (p. 14).

Showing side by side for each month of 1921 and 1922:

- (1) diphtheria incidence in schools *per 10,000 school children*,
- (2) carrier rate *per cent.* in affected schools among children swabbed,
- (3) and, in separate chart below, the percentage proportion of virulent to avirulent carriers among those from whom the diphtheria bacillus was isolated and tested for virulence.

NOTE.—The rise and fall in carrier rate would appear generally to correspond with the rise and fall in case incidence, more particularly in (N.W.) Hampstead, (N.E.) Islington and Shoreditch, (S.E.) Bermondsey, Camberwell and Woolwich, (S.W.) Southwark, Battersea and Wandsworth.

The corresponding seasonal case incidence and carrier rate are represented by the rise in the autumn and winter months and fall in the summer months in each year, more evident in 1921.

The percentage proportions of virulent to avirulent carriers tend to approximate when diphtheria prevalence and carrier rate are relatively low, i.e., in the summer months, but become widely separated with the rise in case incidence and carrier rate in the autumn and winter months, when the ratio of the virulent considerably exceeds that of the avirulent.

CHART VIII. (p. 16).

Provides the diphtheria rate *per 10,000* for each month of 1921 and 1922:

- (1) \*for the school age period 5-15 years for all London and (below) the corresponding mortality† case rate *per cent.*
- (2) \*for the separate age periods 5-10 and 10-15 side by side and below corresponding mortality† case rate *per cent.*

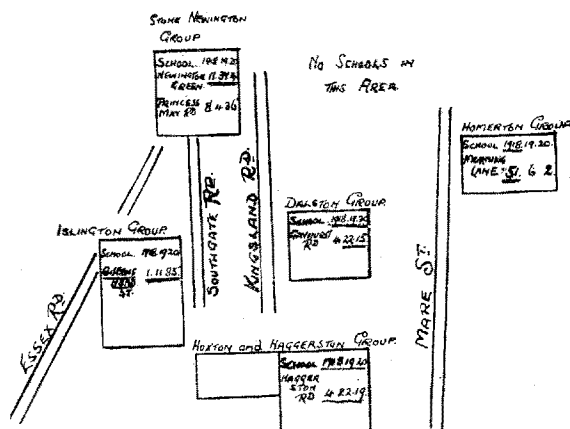
Judging from the ground traversed by the epidemic in 1921 and 1922, also in point of time, its course would seem to be one beginning in

†For tabulated and charted results, including diphtheria incidence and school carrier rate, see Table (p. 18) and Charts I.—VI. (1921 and 1922).

\*From M.A.B. notifications.

†From Registrar General's figures.

1918, growing in 1919 and 1920, from a focus of adjoining areas in Stoke Newington, Hackney and Islington, where incidence was also high in the first quarter of 1921, radiating thence to reach various points of the compass in London in the last part of that year, and tending to concentrate during 1922 in the S.W. and more westerly areas of the S.E. (See plan).



NOTE.—The figures in each block under the years 1918-20 indicate the number of cases of diphtheria occurring in the named schools during each of the three years.

In the event of an outbreak of diphtheria in any school, with two or three cases in one classroom, the usual procedure is to arrange a visit to the department concerned at as early a date as possible. The visiting medical officer after preliminary inquiries inspects the children of affected class-rooms and selects a certain number for throat and nose swabbing, either on account of home or class contact with the diphtheria cases, history of previous diphtheria or recent sore throat, unexplained absence from school, or owing to evidence of abnormal conditions of the throat or nose, the object being to discover by bacteriological examination possible diphtheria carriers who may be responsible for the spread of infection.

#### School Carrier rate 1903 to 1922.

Comparison with earlier records of investigations into school diphtheria in the metropolis shows the marked increase called for in the work of school supervision and laboratory diagnosis of recent years. Thus :—

School children.					
	Number swabbed.	B. diphth. present.	Carrier percentage.		
1903	758	58	7.6	...	...
1904	890	60	6.7	...	...
1905	982	95	10	...	...
1906	803	68	8.5	...	...
1907	770	75	10	...	...
1908	1780	93	5.2	...	...
1909	3009	122	4.5	...	...

Average carrier percentage for the seven years among 8,992 children swabbed = 7.5.

During the three years 1920 to 1922, between 17,000 and 18,000 bacteriological examinations of throat, nose and ear of school children have been carried out with the following results, inclusive of re-examinations :—

Year.	Total.	Negative.	Suspicious.	B. diphtheriæ.
				present.
1920	5811	4740=81.6%	350=6%	721=12.4%
1921	6606	5541=84%	419=6.3%	656=9.7%
1922	5401	4553=84.4%	370=6.6%	488=9%

#### Re-admission to school of carriers on negative re-examination.

Previous to April, 1921, children yielding diphtheria bacilli in culture from the throat or nose were excluded from attending school until a repetition of the swabbing yielded one negative bacteriological result. In the case of long-standing carriers it has now been held advisable to require three negative results from successive swabbings at intervals of about a week, before readmission is sanctioned. This additional safeguard against the introduction of possible infection into the schools was judged necessary on the sufficiently established ground, that the presence of diphtheria bacilli, capable of bacteriological demonstration, may be intermittent in certain carriers; particularly those in whom the organism having become lodged in the tonsils is periodically discharged from the depth of the tonsillar crypts, so that there occur alternating positive and negative bacteriological results. The precaution embodied in three negative tests receives support from the paper on "The apparent rate of disappearance of diphtheria bacilli from the throat after an attack of the disease" (Section of Epidemiology and State Medicine, Roy. Soc. Trans., July, 1920, page 286) contributed by Dr. Percival Hartley and Professor C. J. Martin. It was calculated that, where less than three successive negative examinations are required in the case of diphtheria patients discharged from hospital and reported bacteriologically free on the strength of one or two negative findings, the chances of their really carrying were greater, by 29 per cent. for those with one negative test, and by 9.3 per cent. for those with two negative tests, than for those discharged free but really carrying after three successive negative tests—an unknown number designated by x). They also estimated the periods of detention in hospital for cases of diphtheria, previous to discharge, based on :—

One negative result as being 21 days.

Two negative results as being 34 days.

Three negative results as being 45 days.

The advisability, therefore, of applying the same standard of bacteriological test to school children, who are chronic carriers, seems a practicable and justifiable measure, although it is, of course, not regarded as being a hard and fast guarantee of safety against introduction of infection, owing to the occasional intermittence of the carrier condition already mentioned. The possibility of recurrence can, however, be met by the periodic re-examination of past carriers during their subsequent school attendance.

At the end of March, 1921, application was made by Dr. R. A. O'Brien, Director of the Wellcome Research Laboratories, for the supply of strains of diphtheria bacilli obtained in culture from the throat or nose of school children not suffering from clinical diphtheria, which Dr. Eagleton, of those laboratories, wished to have for the purpose of testing for virulence and comparing with strains from cases of the genuine disease. Dr. Eagleton's request was very readily complied with, for it was realised as providing a much-needed opportunity of dividing the school children, who were found to yield morphological diphtheria bacilli in culture, into groups of virulent and avirulent carriers.

The children whose cultures proved virulent were excluded until re-examination on three suc-

cessive occasions gave negative results, or until (as in the twelve cases quoted), the diphtheria bacillus isolated was found to be avirulent. The period of exclusion is a very variable one, and may range from one to six months or longer.

*Details of Bacteriological examinations and virulence tests conducted over a period of two years.*

Between April, 1921, and March, 1923, a total number of 12,017 bacteriological examinations of 9209 London school children were made by stained film preparations of cultures from the throat and nose; of this total 10,139 examinations of 8,020 children (87 per cent.) were passed as negative. In 1,117 examinations of 569 cases, or 6.2 per cent. of all children examined, K.L.B.\* were found, and in 771 examinations of 620 cases or 6.8 per cent., suspicious organisms resembling K.L.B. were reported; thus yielding a total of 1,878 examinations of 1,189 children in whom K.L.B. were found or suspected.

With the object, where possible, of isolating the diphtheria bacillus in pure culture, for transmission to the Wellcome Research Laboratory for virulence tests, detailed investigations by plate culture and sub-culture were carried out in 994

\* K.L.B. = Klebs-Loeffler bacilli (B. diphtheriae).

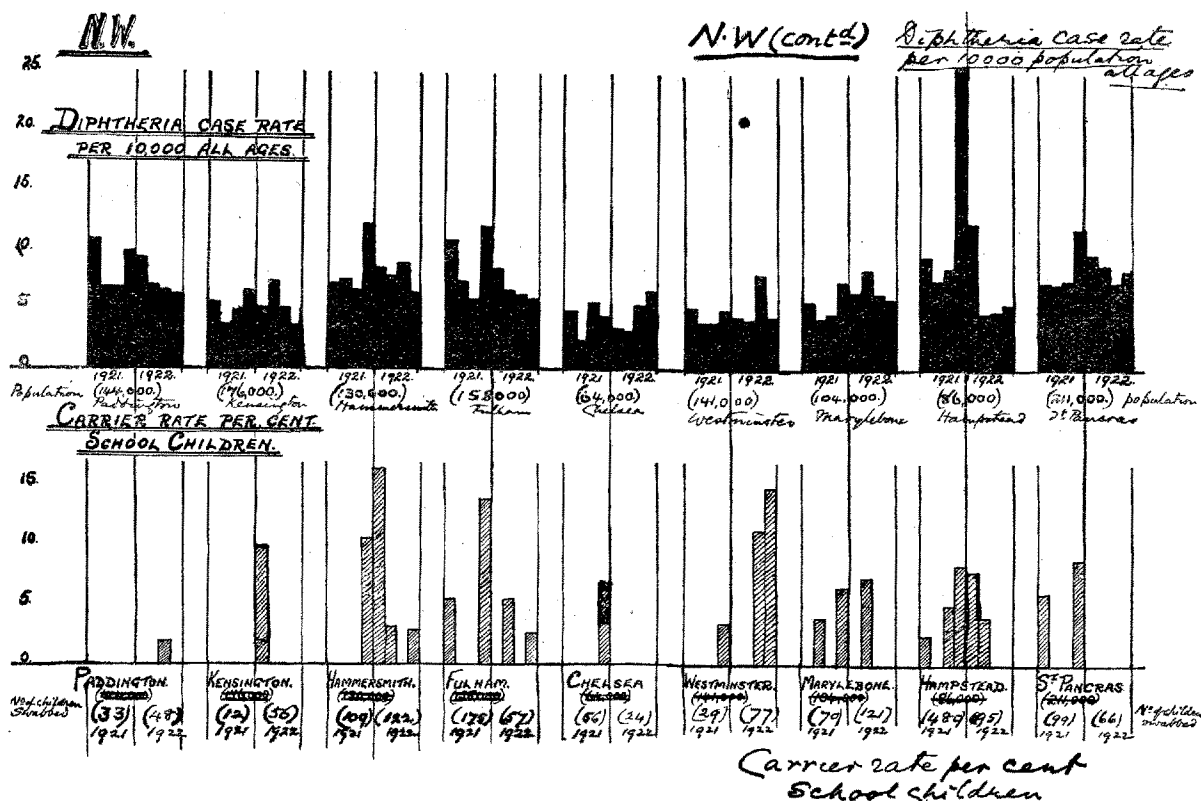


Chart I.

different cases, representing a total of 1,426 separate examinations, selected from the 1,878 in which K.L.B. or suspicious organisms were found in the preliminary cultures from the throat or nose.

The diphtheria bacillus was successfully isolated in 641 examinations of 442 cases, including 62.5 per cent. of the total original positives, and 87 cases which had originally been reported as suspicious. In 206 cases showing K.L.B. in preliminary cultures, attempts at isolating in pure culture failed, the plate cultures yielding diphtheroid organisms or *B. hofmanni* only. 549 detailed examinations were made of cultures from the throat or nose originally reported suspicious, and in 87 of these K.L.B. were isolated; in the remainder only diphtheroids or *B. hofmanni* were

obtained in sub-culture. Twenty-nine examinations were made of cultures from the ear in cases of discharging ears, and in three cases only were true morphological K.L.B. isolated, the remainder yielding diphtheroid organisms. A case of conjunctivitis and one of whitlow also yielded diphtheroid organisms only.

#### Re-examinations.

Of the total cases investigated in detail for the purpose of isolating K.L.B., 146 were examined twice, 51 three times, 17 four times, 16 five times, 4 six times, 13 seven times, one case 8 times, and another 9 times at varying intervals, during the two years.

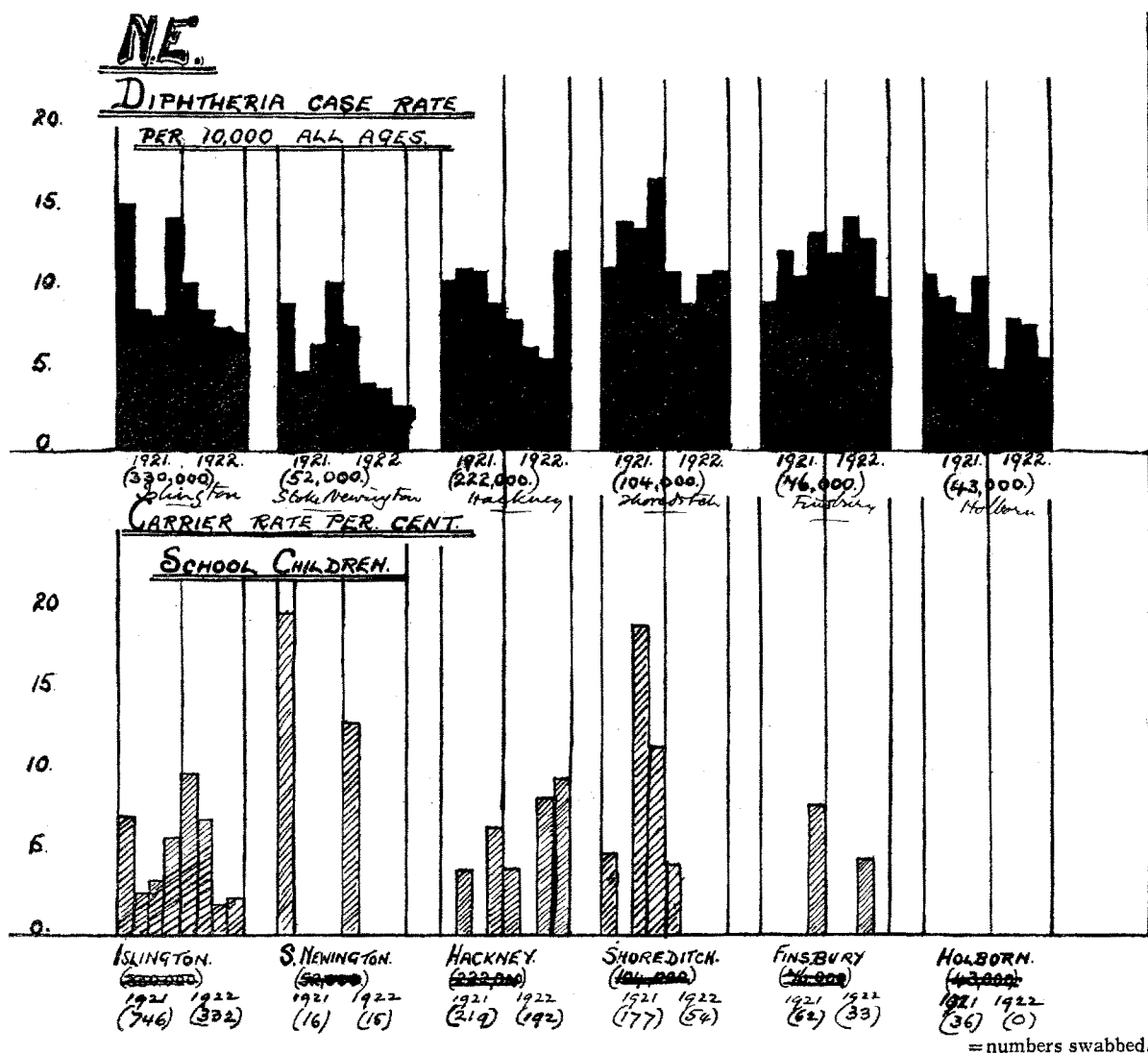
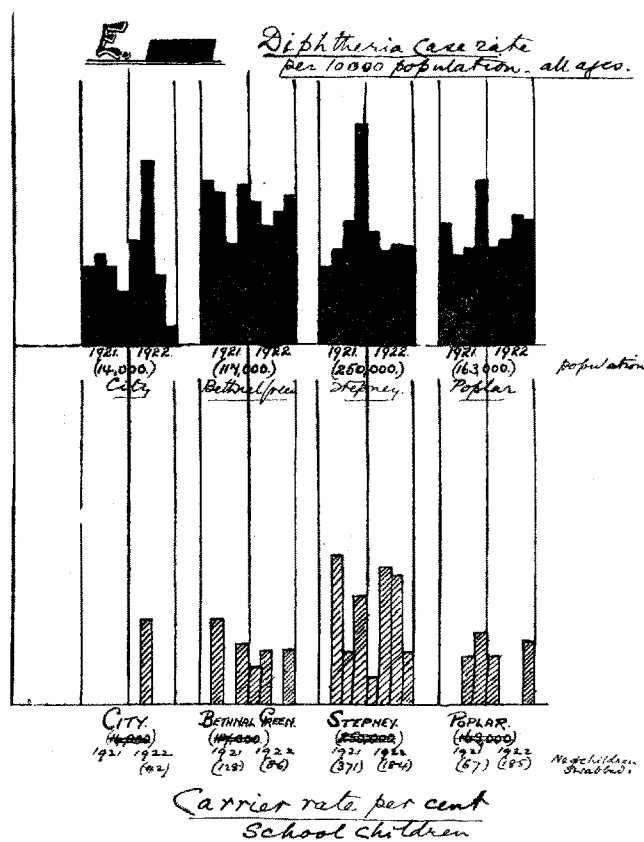


Chart II



In addition to isolating K.L.B. and bacilli belonging to the diphtheroid group, useful confirmatory biochemical tests were applied to a large number of the strains, involving sub-culture in tubes containing Hiss' fluid serum with glucose, saccharose and dextrin, respectively, and blue litmus to indicate fermentative changes.

*B. diphtheriæ* ferments glucose and dextrin with production of acid, but causes no change with saccharose, whereas a common diphtheroid organism such as *B. xerosis* produces acid in the glucose and saccharose, but not usually with dextrin, and *B. hofmanni*, the commonest of the diphtheroids, fails to change any of the three.

#### *Results of virulence tests.*

The isolated cultures of K.L.B. obtained in the 641 separate examinations of 442 cases were sent to the Wellcome Research Laboratory for virulence tests with the following results:—

Examinations.	Cases.
Virulent in ... 390 (=60 %)	of 291 (=65.8 %)
Avirulent in... 251 (=40 %)	of 151 (=34.2 %)

(including 12 cases, in which the original cultures were found to be virulent in 18 examinations, and the cultures in 26 subsequent examinations, avirulent). In addition to the cultures of morphologi-

cal K.L.B., 78 cultures of diphtheroid organisms from the throat and nose and four from the ear, isolated from 71 cases, were also sent for virulence testing, and in every instance proved avirulent. The total number of strains of diphtheria bacilli and diphtheroid organisms tested for virulence between April, 1921, and March, 1923, amounted to 719 from 513 cases.

*The relationship of virulence to abnormal conditions of the throat or nose and history of exposure to infection.*

In 423 of the 442 cases, in which the K.L.B. were tested for virulence, particulars were stated of either abnormalities of the throat, nose or ear; history of sore throat or other illness; history of sore throat or diphtheria carriers in members of the family, or contact with cases of diphtheria. 283 were recorded as showing defects of the throat nose, or ear, *e.g.*, tonsillitis, enlarged, unhealthy or congested tonsils, congested fauces or uvula, pharyngitis, nasal discharge, excoriation of the nasal passages, nasal crusts, adenoids or otorrhœa.

The results of the virulence test in these cases were as follows:—

(1) Cases with defects of throat and nose:—
The diphtheria bacillus was virulent in ... 190 = 68 %
The diphtheria bacillus was avirulent in ... 90 = 32 %
K.L.B. isolated from three cases of Otorrhœa.
Virulent, 2. Avirulent, 1.

#### (2) History of illness or contact with infection:—

	History of sore throat or illness of cold.	History of having been in hospital with diphtheria.	History of having been in hospital with scarlet fever.	Family history of sore throats or carriers.	Home contacts of cases of diphtheria.
K.L.B.					
Virulent in	39	13	4	14	27 cases.
K.L.B.					
Avirulent in	18	5	—	3	11 cases.

Desk contacts in school:

Virulent	...	...	...	14
Avirulent	...	...	...	5

No history obtained as to contact with infection. No defects recorded.

K.L.B. Virulent	...	...	...	19
K.L.B. Avirulent	...	...	...	10

In Dr. Eagleton's and Miss Baxter's series of 161 cultures of diphtheria-like organisms (published in Brit. Med. J., Jan. 28th, 1922):—

Cultures of *B. diphtheriæ*:

- (1) from clinical cases 100 per cent. virulent.
- (2) from convalescents 90 „ „ „
- (3) from carriers 38.8 „ „ „

Guthrie (3) claims that in the majority of healthy carriers the K.L.B. present are avirulent.

### Serological Classification of Virulent Diphtheria Bacilli.

The classification of strains of *B. diphtheriæ* by serological agglutination tests has been the subject of study by various laboratory workers for over 20 years, originally for the purpose of distinguishing the true organism from *B. hofmanni* and other diphtheroids, later as a possible means of separating virulent from avirulent forms or morphological *B. diphtheriæ*. Broadly speaking, serological tests afford a rough distinction between the two; for the great majority of virulent strains are agglutinated by one or other of the various types of sera now in use, whereas the majority of avirulent are inagglutinable. The most recent observations on this subject were contained in a paper by Dr. A. J. Eagleton and Miss Edith Baxter, read before the Pathological Section of the Royal Society of Medicine (Jan. 16th,

1923), which dealt with the classification of close on 350 virulent strains derived from various sources, including diphtheria cases, contacts, convalescent and healthy carriers during 1921 and 1922.

In their classification the authors recognised ten distinct serological types of the virulent organism and foreshadowed the existence of yet others.

It may be briefly stated that the majority (two-thirds) fell into one of four groups. Type III., 43 %; Type V., 18 %; Type II., 9 %; Type I., 7 %, of the remainder 18-19 % were distributed among the other groups and 4-5 % were unclassified. Their collection included 50 cultures from our school carriers. To these I have added a further 20 which, thanks to Dr. Eagleton's kindness in supplying me with his type sera, I was able to classify serologically.

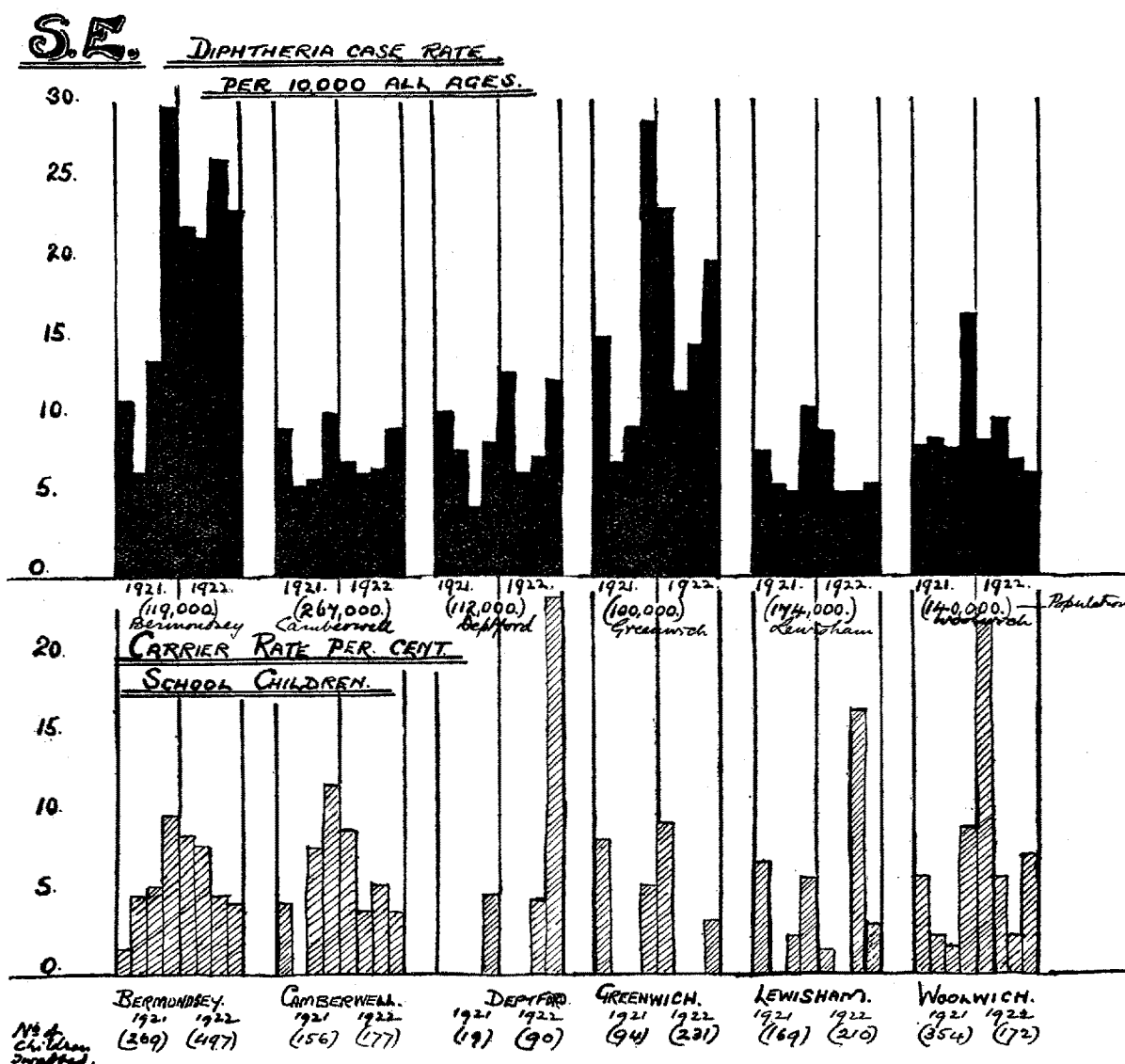


Chart IV



nose of 10 of the children, including D.C., who was found to have nasal discharge and sores in the nostrils, and was straightway excluded. Cultures from D.C. yielded abundant K.L.B., especially from the nose. Another child, B.W., was also excluded on account of enlarged unhealthy tonsils, congested pharynx and uvula,—she too yielded K.L.B. from the throat. Of the remainder, 8 proved negative and 1 suspicious, but no K.L.B. were identified.

G.C., a sister of D.C., but in the girls' department; was swabbed at the same time and also yielded K.L.B. from the nose. The organism was isolated in pure culture from both D.C. and G.C., and also from the other child B.W. excluded on suspicion at the original class investigation. In each case the organism proved to be virulent, and serologically Type III. On inquiry at the home of the two sisters (C.) it was learnt that their mother had been suffering from sore throat and the father was under treatment for "abscess in the throat."

In this connection it may be stated that the evidence forthcoming not only from the bulk of recent investigations in 1920-1922 into the school incidence of diphtheria, but also from special inquiry on the point in time past by Dr. J. Kerr,<sup>17</sup> goes to show that the part played by schools in the spread of the disease is of relatively secondary importance as compared with the influence of home and out-of-school surroundings and places of resort, which, being more beyond immediate control and supervision, are probably far more potent factors in the dissemination of infection.

#### *Carriers in the Same Family.*

The number of instances in which two or more members of the same family proved to be carriers was as follows:—

Two carriers in 22 families.
Three   ,,   ,,   8   ,,
Four   ,,   ,,   3   ,,

K.L.B. though present were not successfully isolated in each case, but it was found that when isolated from pairs and tested for virulence, it did not necessarily follow that the two carriers in the same family were simultaneously virulent or avirulent. Of twelve families so investigated, five pairs proved virulent; and in four pairs, one of each pair was virulent, the other avirulent; and three pairs were avirulent. In two families (W. and T.) where three members of each family were carriers, the three in each group all proved to be virulent at the same time on more than one

occasion. In the families with four carriers, though present in all four, K.L.B. were only isolated from two members of each of the three families, proving virulent in two pairs and avirulent in one pair.

Similarly, amongst carriers occurring in the same class at school, virulent and avirulent strains were isolated from different individuals on the same date. Theoretically in explanation of such variation, it might be suggested that the question of virulence or avirulence is determined or governed by some unknown mechanism of defence peculiar to the individual concerned.

#### *Intermittence Among Diphtheria Carriers.*

Among family contacts intermittent carriers were by no means uncommon, notably in the two families (W. and T.); at one time, all three were positive, at another, one or two only, and so the condition seems to continue, one apparently re-infecting another in succession over a period it may be of six months or longer. It has, on the other hand, been found that a single carrier may persistently prove positive and virulent on each occasion of swabbing for many months without any evidence of intermittence.

#### *The Re-admission of Avirulent Carriers.*

By means of the virulence test it has been possible to allow the immediate readmission of all those found carrying the avirulent organism, without the delay of repeated bacteriological examination and often long waiting for negative results formerly required, thus avoiding much loss of school attendance for the children concerned.

During the past two years it has been calculated in the case of 33 avirulent carriers that their re-admission to school on the results of the virulence test has or would have avoided the loss of no less than 166 months, or close on 14 years of school life, an average of 5 months for each child concerned. For it was found in subsequent swabbings that the carrier condition persisted after re-admission for periods ranging from one to twenty months or even longer.

For the six months ending February, 1923, it has also been found that the average period of exclusion of *avirulent* carriers has been 2.9 weeks, and for each *virulent* carrier, before yielding 3 negative swabbings, 10.5 weeks.

In the case of the former, this period has been dependent on the time taken to isolate B. diphtheriæ and in obtaining the performance of a virulence test, obviously capable of considerable reduction where bacteriological and animal tests are carried out in the same laboratory.



Recent examinations after long intervals of 14 past avirulent carriers showed that 7 of them were still avirulent carriers:—

Carrier condition first recognised.	Dates of virulence test.	Re-examination.	Period as Carrier.
H.G. 3.10.19	22. 4.21 Avirulent	26. 1.23 Avirulent	{ 3.4/12 years. 1.9/12 avirulent. }
I.P. 10.12.19	25. 4.21 } Virulent 31.10.21 } 12.12.21 Avirulent	13. 2.23 Avirulent	{ 3.2/12 years. 1.2/12 avirulent. }
R.P. 8.11.19	6. 5.21 Avirulent	3. 2.23 Avirulent	{ 3.3/12 years. 1.9/12 avirulent. }
M.G. 6. 5.20	27. 5.21 Avirulent	16. 2.23 Avirulent	{ 2.9/12 years. 1.9/12 avirulent. }
L.G. 25. 6.21	30. 6.21 Virulent 30. 8.21 } 22.12.21 Avirulent	18.11.22 Avirulent	{ 1.6/12 years. 1.3/12 avirulent. }
E.M. 8.9. 21	21.10.21 Virulent 9.12.21 Avirulent	26. 1.23 Avirulent	{ 15 months. Over 12 months avirulent. }
T.S. 15.12.21	15.12.21 } 15. 4.22 } Avirulent	27. 1.23 Avirulent	{ Over 12 months avirulent. }

In the absence of the virulence test and adopting the former practice of excluding a carrier till negative bacteriological results were obtained, these children would, presumably, have been excluded for periods of years.

The return of children, though carrying organisms morphologically and culturally indistinguishable from the diphtheria bacillus, but avirulent, has led, so far as can be ascertained, to no harmful results. There is moreover no evidence yet forthcoming from reliable sources of investigation that the avirulent strain of diphtheria organism may become virulent—in other words, from the evidence present knowledge affords, the organism remains true to its type of virulence or avirulence. It is, however, recognised that in quite rare instances virulent and avirulent strains may exist at one and the same time and be obtained in the same culture from the throat or nose. This exceptional occurrence has been found in two cases (L.S. and W.P.) out of a total of 442 children (or less than .5 per cent.), whose diphtheria cultures were sent to the Wellcome Research Laboratory for the virulence test during the past two years. In a third case (M.T.) the K.L.B. isolated first from the nose in April, 1922, proved to be avirulent; a month later, however, reswabbing yielded K.L.B. from throat and nose and the organism isolated only from the throat was found to be *virulent*. R.T. (M.T.'s sister) suffering from a profuse nasal discharge was a nasal carrier in September, 1921. The K.L.B. isolated at re-examinations in October and November, 1921, from the nose proved avirulent.

The two strains may also very uncommonly alternate. The rare coexistence or alternation of the two types is regarded as being probably due to reinfection with one or the other strain of organism, or to simultaneous infection with both. "The risk of the virulent supervening on the avirulent is probably no greater in the case of a carrier, than in the case of the ordinary person becoming a harbourer of virulent K.L.B."\* (Dr. O'Brien). Though indistinguishable morphologically and culturally, efforts at the Wellcome Research Laboratory, Dr. Eagleton also states,<sup>2</sup> have quite failed to change the virulent into the avirulent (and vice versa) in the test tube. "We have so far found no evidence that a culture may lose its virulence on being kept." Further, in his hands no success has up to the present attended the attempt to produce immunity to virulent strains by the injection of massive doses of the avirulent strain. Guthrie and his associates,<sup>3</sup> publishing the results of their observations on diphtheria carriers in the John Hopkins Hospital Bulletin, November, 1920, find no proof that avirulent bacilli can acquire virulence or give rise to clinical diphtheria, hence avirulent carriers are not regarded as a menace to anyone. The carrier of virulent K.L.B., however, occupies quite a different position.

The following test was applied by Guthrie to prove the non-virulence of avirulent K.L.B. Five healthy volunteers, who had been tested daily for two weeks and found negative, had their throats swabbed with pure cultures of avirulent bacilli; some became carriers of avirulent bacilli, but without developing clinical diphtheria or showing the presence of virulent K.L.B.

Eight other volunteers were subjected to the severer test of application of cultures of the virulent organism to their throats. Four of them developed clinical diphtheria.

Schick tests had been previously applied to each of these volunteers and showed that the four who developed diphtheria were positive and therefore possessed no natural immunity, whereas the four who did not acquire diphtheria, were found to be negative and therefore naturally immune.

Guthrie also maintains that avirulent supervening on virulent and vice versa is attributable to reinfection, and does not imply a change of one type into the other.

The rare combination of virulent and avirulent strains is a complication difficult to explain, or to guard against, save by the aid of periodical re-examination. Twelve of the cases among school

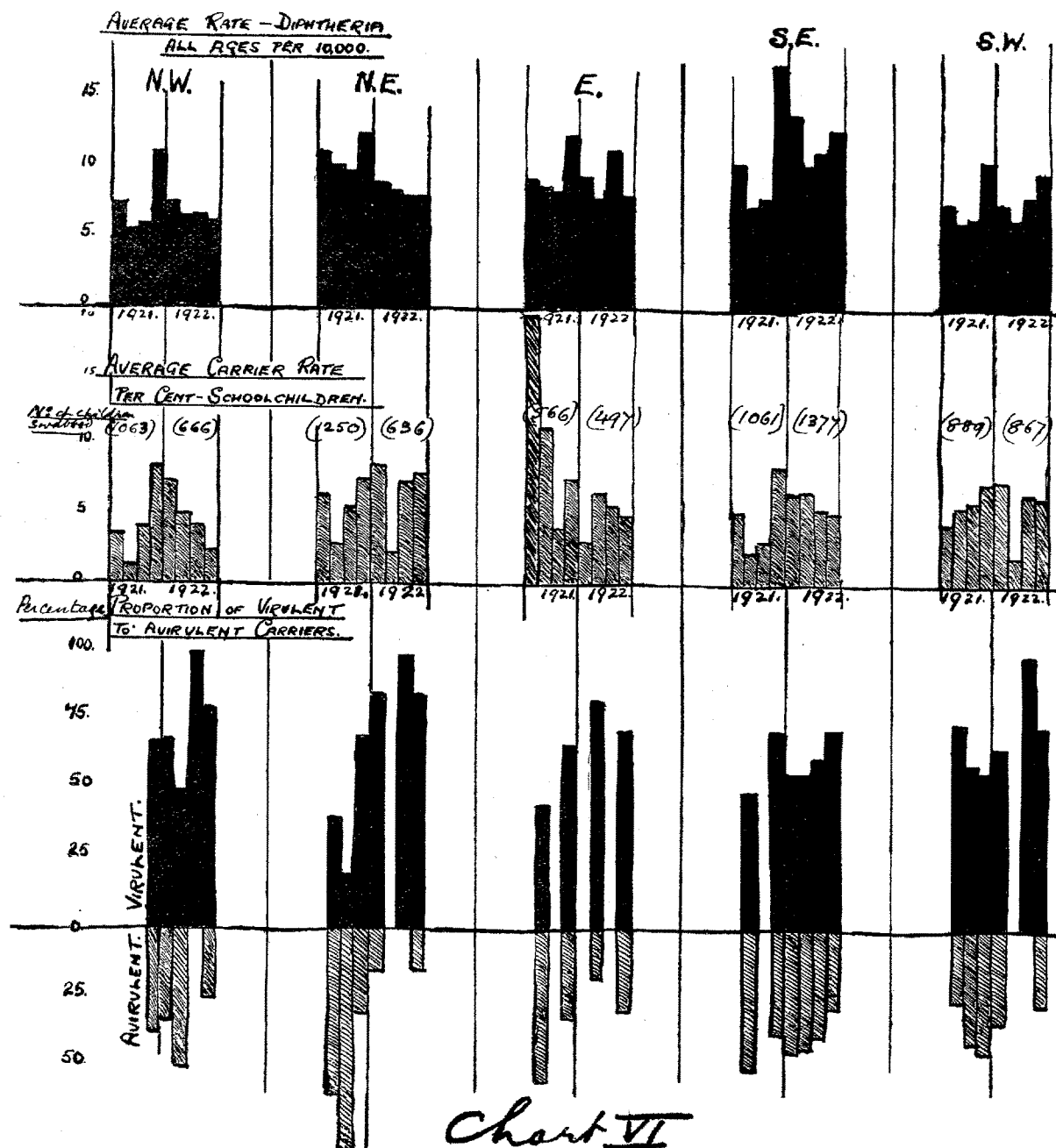
\*Vide also (2) B. M. J., Jan. 28, 1922, p. 139, "Virulence of diphtheria-like organisms." (Eagleton & Baxter.)

children (or 2 per cent. of the total tested for virulence) were originally proved to be virulent in 18 separate examinations, and after varying periods of 6 to 12 weeks, yielded avirulent strains in 26 subsequent re-examinations. They were, therefore, readmitted to school, and so far as can be ascertained, without harmful result.

One case (L.S.), originally avirulent, was 3 months later found to be carrying both virulent and avirulent at the same time, and 10 weeks later virulent only, probably an instance of re-infection by virulent K.L.B.

With these exceptions, then, the experience provided by the animal test in the present series,

by repeated application to successive cultures from the same cases, has consistently maintained a clear division between morphologically indistinguishable virulent and avirulent diphtheria bacilli; hitherto also immunising experiments have failed to establish relationship between the two, and laboratory culture to convert the one into the other. In the human subject, however, although the evidence that the avirulent organism may become virulent, or give rise to clinical diphtheria is *not* forthcoming, the change from the carrier condition of virulent into one of avirulent is one which, although uncommon (in two per cent. of this series), undoubtedly occurs and cannot be ignored.



Future research and observation may establish the cause of this change; whether it is merely the disappearance of the virulent organism and subsequent reinfection with the avirulent? Whether the carrier, by the immunity from clinical diphtheria he appears to enjoy, is capable not only of tolerating the virulent organism, but also of depriving it of its virulence, so that it becomes a harmless saprophyte, and remains such, even when transmitted to others? Whether avirulence represents a degenerative phase or reversion to ancestral type, and virulence an acquired character resulting in the production of specific toxins in the non-immune? The problem of the relationship of the virulent and avirulent organisms is one of absorbing interest, still awaiting solution. So far as our present knowledge goes, one may be justified in relegating them to two separate groups. But it is difficult to dogmatise to the extent of saying that though virulent is virulent, avirulent avirulent, the twain ne'er shall meet!

In the course of investigation of school outbreaks a certain number of children are met with who have had past attacks of diphtheria and are still found to be carriers. Out of 16 such, 12 proved to be virulent and 4 avirulent. In the case of the latter the result of the test, I take it, should serve to allay suspicion of their responsibility as possible foci of infection. Can one assert with confident assurance that the avirulent carrier with a past history of frank and recent diphtheria is not a source of danger? Presumably; for one can state that the experience of the presence of avirulent carriers, now accumulating under observation in our schools, has not afforded ground for regarding them as sources of danger.

Granted that avirulent carriers can be safely ignored as sources of infection, the question then arises as to what extent the virulent carrier is to be regarded as a danger to others in the school. The example quoted of fatal infection traceable to the virulent carrier D.C. may be considered an extreme case. Is, therefore, a hard and fast line of exclusion of virulent carriers justifiable or necessary? It is known that if any school be selected at a time of non-diphtheria prevalence and all the children be swabbed, a few may be found to be diphtheria carriers. Of these chance carriers probably  $\frac{2}{3}$  would be avirulent and  $\frac{1}{3}$  virulent (Dr. Eagleton). In such a school, in the absence of clinical cases of diphtheria the virulent carrier is presumably not a source of danger. [c.f. Dr. Eagleton's figures (p. 5) carriers = 38.8 % virulent.]

However, when diphtheria becomes prevalent, either the increased susceptibility of individuals, or the heightened virulence of the bacillus, renders the virulent carrier an object of suspicion, if not actual danger. Judging, too, from the results of virulence tests applied to school carriers during the past two years, April, 1921, to March, 1923 (when diphtheria was unusually prevalent, it would appear that the proportion of virulent \* carriers is greatly increased during a time of epidemic; and as the block chart shows, the ratio varies with the number of cases each month; the ratio of the one to the other was found to be directly reversed from one-third virulent and two-thirds avirulent, the estimated ratio in normal times, to two-thirds virulent (67 per cent. actually found) and one-third avirulent (33 per cent.) for the period of diphtheria prevalence under review; whereas during the early summer months, when prevalence was lower, the proportion of virulent to avirulent was about equal.

The corrected percentage of carriers found among the children examined in 1921 and 1922 in London, is 6.2. But that figure is found to be much increased where there is a rise in diphtheria prevalence. Thus in 40 schools, where over 400 cases of diphtheria had occurred, the carrier rate among a total of over 900 children swabbed proved to be 13 per cent. Of these positives, over 77 per cent. were virulent, and under 23 per cent. avirulent.

Exclusion would then seem the safer course, and justified (1) if the carrier shows an unhealthy condition of the throat and particularly of the nose.

(2) If the organism is present in culture in considerable numbers and can be isolated with ease. As Dr. O'Brien has recently emphasised, the presence of the diphtheria bacillus in relatively small numbers, not allowing of ready isolation in plate sub-culture, should not be judged as sufficient evidence of power to transmit infection or to warrant exclusion. By steering such a middle course and at the same time exercising supervision over the non-excluded mild carrier, it is suggested that a practical solution may be arrived at so far as sources of school infection are concerned.

\* Charts VI. and VII. for seasonal incidence of diphtheria in schools and comparison in the carrier rate and virulence ratio.

*Some previously Recorded Observations on the Diphtheria Carrier.*

In dealing with the carrier question in time past, measures advocated have not been at all generally guided by the virulence test. The Massachusetts' Boards of Health Association,<sup>18</sup> (1902) emphasised the impracticability of isolating healthy infected persons not recently exposed to the disease, or, as a routine measure, the healthy contacts in infected families, schools and institutions; but in the case of children it was held advisable that contacts of infected families should be excluded from day schools, Sunday schools, and all public places.

Dr. C. J. Thomas<sup>19</sup> in 1904 drew attention to the importance of the age period of 5—8 years as providing a large proportion of children who, from the increasing degree of acquired immunity, were liable merely to mild unrecognised attacks of diphtheria with slight symptoms, and therefore capable of spreading infection unchecked—such cases were found on bacteriological examination to amount to 80 per cent. of the total carriers—of the remainder, 12 per cent. presented no symptoms but came from infected homes, 6 per cent. were cases of recrudescence after absence for notified diphtheria (return cases), and 2 per cent. were carriers without symptoms or obvious contact with infection.

Dr. D. S. Davies,<sup>20</sup> similarly, in 1907 laid stress at Bristol on the necessity for prevention of diphtheria by efficient organization for the bacteriological examination of all contacts in infected homes and school class-rooms, and by recognition of the risk attaching to mild cases with but slight clinical symptoms, as well as to the carrier without symptoms. He regarded home infection as more responsible for spread of infection than the school.

Dr. A. G. Macdonald<sup>21</sup> in a review of 90 carriers found out of 1,178 contacts (7.6 per cent.) examined at Crewe in 1910, obtained a total of 62 positives out of 534 home contacts (11.6 per cent. carriers), and 28 positives out of 644 school contacts (4.3 per cent. carriers), thus showing the higher carrier rate among home as compared with school contacts.

He classified the carriers into (1) those without clinical evidence of diphtheria, the infection lasting but a short time; (2) those with history of "sore throat" or "cold," mild neglected cases of diphtheria; (3) those without symptoms but with local lesion of throat, nose, skin, or ear; (4) those who have had clinical diphtheria and in whom diphtheria bacilli persist for long periods.

He regarded the length of carrier life as having no effect on virulence, and the control of diphtheria as dependent on the control of the carrier.

Dr. Thos. F. Harrington,\* in September, 1909, examining supposed normal school children in Boston, U.S.A., obtained 99 positive results to K.L.B. out of over 8,500 examinations, or 1.16 per cent. He therefore concluded that at least 1 per cent. of healthy school children are carriers, and that though the organism may be communicable, it is usually avirulent and the condition transient.

According to Zingher,<sup>9</sup> an average of 4 to 5 per cent. of diphtheria carriers always exists in New York City.

Guthrie, Gelien and Moss<sup>3</sup> swabbed 800 children in Baltimore schools and found 85 (or 10.6 per cent.) to show K.L.B., and three months later 69 or 8.6 per cent., and at one time or other 160 were obtained as positive. Virulence tests applied to 99 showed only 9 virulent. Eleven of the 160 carriers gave history of diphtheria, but none of them within three years.

Vernieuwe<sup>15</sup> (quoted in B. M. J. Epitome 87, January 27th, 1923, from Rev. de Laryngol d'otol et de Rhinol, December 15th, 1922) divides diphtheria carriers into four classes.

- (1) Convalescents from an acute attack—carriers by continuity of infection.
- (2) Carriers with no visible lesion (past or present).
- (3) Accidental carriers in whom diphtheria bacilli are found on a raw surface, e.g., following intranasal or naso-pharyngeal operation.
- (4) Carriers who have active nasal diphtheria with no constitutional invasion.

*Treatment of Abnormal Conditions of the Throat and Nose in Carriers.*

The condition of the throat and nose of the chronic virulent carrier is seldom found to be normal. Almost invariably there exists an enlarged, unhealthy state of the tonsils, nasal obstruction, adenoids or chronic rhinitis, with ulceration of the nasal mucous membrane. Such conditions imperatively call for remedy in the interests of the child and his associates, particularly at a time of diphtheria prevalence in schools, when any child with an unhealthy condition of the fauces or nasal passages must be regarded as a potential carrier of infection.

Although the value of the virulence test, by allowing the avirulent carrier to return to school

\* (Paris Congress I., p. 272, 1910.)

and thus considerably reducing the number of children, who would otherwise have been excluded, cannot be denied, the problem yet remains of dealing with the persistently virulent carrier.

In the schools this has been partly met by supplying special means of treatment in a very limited number of cases and as a trial measure, such as the removal of enlarged unhealthy tonsils and adenoids, and by the use of nasal douche or suitable gargle, and close attention to the condition of the nasal and accessory sinuses. The carrier is no *persona grata* in the hospital outpatient department; in fact, requests for treatment of the condition at several of the hospitals have been met with refusal. Consequently a special clinique has been arranged for the past two years under the charge of Dr. A. G. Wells, for dealing with the obstinate carrier.

During 1920, 13 chronic carriers, and in 1921, 24, received special treatment varying according to the nature of the individual condition, e.g., nasal catarrh, rhinitis, pharyngeal catarrh, enlarged tonsils or adenoids. Weekly swabs were taken and the child was not re-admitted until three successive swabs proved negative. During 1920, 9 of the 13 cases were re-admitted to school after a period of 4 to 6 weeks, and the remainder often intermittently gave positive and negative results until they were finally re-admitted to school. During 1921, 5 were re-admitted after one month's treatment, 11 after two months, 2 after three and four months, 3 after 5 months, 1 after eight months', nine months' and twelve months' treatment respectively, having during that period become negative, or been proved to be avirulent carriers. Ionisation, so promising in the treatment of chronic otorrhoea, at present offers little prospect of practical application to the throat and nose to free the chronic diphtheria carrier.

Radical treatment by removal of tonsils and adenoids in chronic carriers usually proves quite successful in eradicating the carrier condition in which, as observed by Graham Smith, deep lodgment of K.L.B. is found to exist in the tonsillar crypts.

Rare exceptions may occur, as in the case of the famous R.C., who persisted as a carrier for several years, and even after enucleation of the tonsils—a condition attributable probably to chronic nasal sinus infection.

Councilman, Mallory and Pearse,<sup>22</sup> in a series of examinations of 52 fatal cases of diphtheria, found evidence of inflammation of the maxillary antra or accessory sinuses in 33 (or 63 per cent.); in 28 of which diphtheria bacilli were found on

cultivation, although no clinical symptoms of antrum disease or sinusitis existed during life. They therefore considered that the chronic carrier conditions of the nasal passages may, in a certain proportion of cases, be due to chronic antral or sinus infection, calling for special treatment.

Rapid clearing up of the carrier condition after removal of tonsils has been reported by Bal-lantyne and Cornell<sup>5</sup> (B.M.J., November 24th, 1917) and by Graham Brown and Kent Hughes<sup>6</sup> (Medical Journal of Australia, April 17th, 1920). The latter found that 12 per cent. of 800 school children at Windsor (Brisbane) were diphtheria carriers—50 carriers identified among 286 admissions to the children's hospital (Brisbane) when operated on were found to be free from K.L.B. 8 to 16 days after tonsillectomy. In 24 of the 50 the tonsils were enlarged, in 7 greatly enlarged, and in 19 no enlargement was recorded.

In the treatment of carriers by diphtheria vaccine, in doses of 10 to 200 million bacilli, J. L. Brownlie,<sup>7</sup> of Glasgow, claims that out of 50 cases, 37 cleared up in a week, 7 in a fortnight, and 6 after a longer interval. He found that local antiseptic applications were unreliable remedies, that vaccine treatment resulted in degenerative changes of the bacilli, followed by their complete disappearance from the part invaded, and therefore vaccine administration was not only effective, but economically a sound procedure.

A. R. Fraser and A. G. B. Duncan, of Aberdeen,<sup>8</sup> have also strongly advocated the use of diphtheria vaccine and suggested that a carrier possesses a certain degree of immunity, sufficient to inhibit the organism from producing clinical diphtheria, but quite insufficient to exterminate them.

They attributed the failure of many of the specific vaccines to their high endotoxin content, which prevented any but small doses being administered, whereas a large dose was essential. For, by employing detoxicated vaccines in doses of 4,000—350,000 million K.L.B. subcutaneously, they claimed to have secured very encouraging results, leading to complete disappearance of the organism and without the development of any general or local reaction; only, however, in three tested cases of persistent carriers of virulent bacilli.

They differentiated the merely "positive throat" from the true diphtheria carrier; in the former the bacilli disappeared spontaneously or after a short period of disinfectant treatment, and the condition was readily curable by one or two doses of stock vaccine, whereas the true chronic carrier


was persistently virulent and defied all other ordinary lines of treatment.


The more recent work of W. T. Benson on "the effect of detoxicated vaccines on the persistence of the diphtheria bacillus," (Lancet, May 5, 1923, pp. 895-897), in 146 treated cases and 61 controls, led him to the conclusion that the administration of the detoxicated vaccine did not hasten the disappearance of the diphtheria

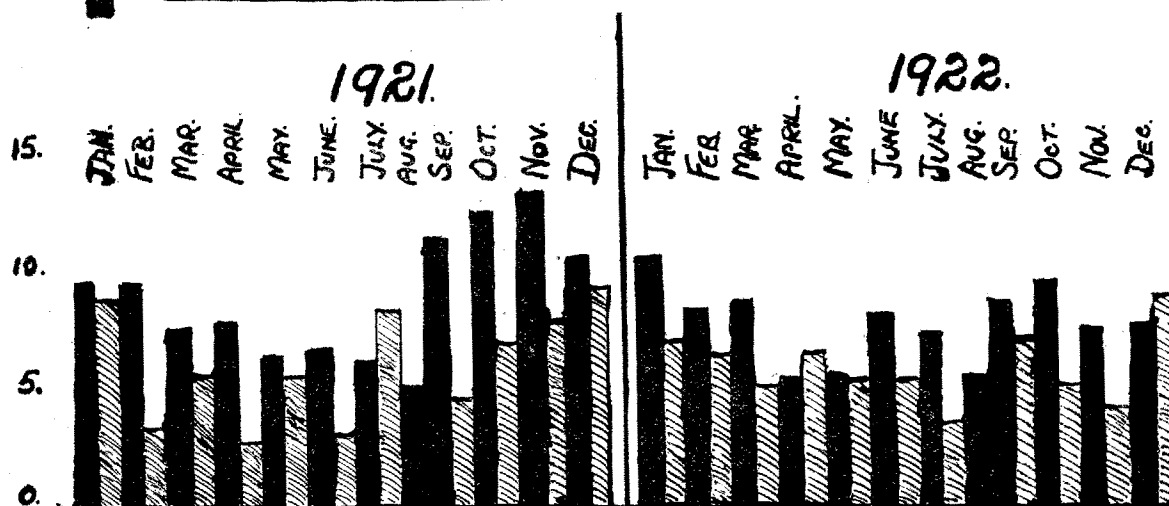
bacillus from the throat or nose of the diphtheria convalescent, or prevent cases of prolonged persistence of the carrier condition.

Despite ordinary remedial measures, surgical treatment and the suggested value of vaccine inoculation, the problem of freeing the persistent virulent carrier remains, however, an extremely difficult one, entailing often prolonged absence from school and consequent loss of education.


## Chart VII


 = CARRIER RATE PER CENT.

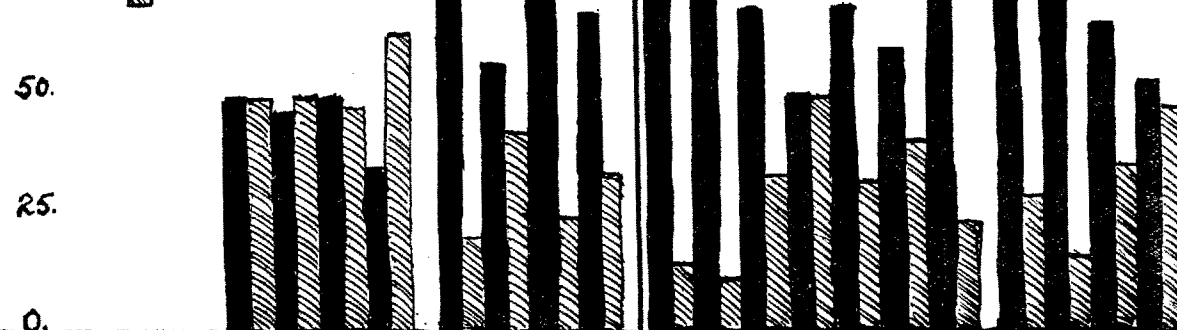
 = DIPHtheria CASES IN SCHOOLS  
RATE PER 10,000.



### PROPORTION OF VIRULENT TO AVIRULENT CARRIERS PER MONTH.

100.  = VIRULENT.

75.  = AVIRULENT.



The Black Spaces for August represent the period of the School Holidays.

*The Control of the Chronic Virulent Carrier.*

The scope for dealing with the carrier is at present strictly limited and likely to remain so. Exclusion from school of the positive virulent carrier and home contacts is all that can be insisted on. The consent of the parent is necessary before any remedial measures can be applied for abnormal conditions of the throat and nose, which favour the persistence of the diphtheria bacillus. Outside the school, the carrier is usually free to disseminate infection, more so where parental control is lax and indifferent. In all such cases close supervision, if not active precautions, to the full extent of his powers, devolves on the Medical Officer of Health to prevent the carrier, excluded from school, from being a source of danger in cinemas, Sunday schools, and other places where children may happen to congregate in and out of doors.

(As already pointed out, compared with these out of school possibilities of spreading infection, the influence of the school is of relatively secondary importance.) Sanction for such control provided, if need be, by special legislation might be advisable to meet periods of special prevalence.

No children after suffering from diphtheria and being discharged from hospital should be re-admitted to school until the results of bacteriological test establish their freedom from infection, and until the condition of the nose and throat is normal.

Since in Dr. Eagleton's series over 90 % of diphtheria bacilli, obtained from children shortly after an attack of diphtheria, were virulent, the only safe rule in the absence of facilities for determining the virulence, is, Dr. O'Brien observes, to assume that all diphtheria bacilli obtained from these children are virulent and therefore liable to cause infection amongst school mates.

Unfortunately artificial immunisation by toxin-antitoxin apparently offers little prospect of removing the carrier condition in the case of the virulent carrier, for he is according to Dr. O'Brien almost invariably Schick negative—and would therefore not respond. Vernieuwe (previously quoted), however, in recording the cases of seven virulent carriers with active nasal diphtheria but no constitutional symptoms, states that the bacilli form a virulent focus and in the majority, if not all, of the cases continue to produce a Schick positive reaction, and that, consequently, nasal diphtheria in this type of carrier does not produce immunisation.

The general practitioner is often directly concerned in the treatment of the carrier and should be kept informed as to the results of bacteriologi-

cal examination and virulence test, to enable him to influence the parent as to the necessity of preventing the child from visiting places where there is risk of his disseminating infection.

Coordination therefore between the various authorities concerned in fever-hospital, school, public health and private practice, should be aimed at to secure the following up of both the discharged convalescent after diphtheria, and the virulent carrier, where found.

Much perhaps is to be said for the suggestion put forward by Sir F. W. Andrewes,<sup>16</sup> in a paper on the prevention of diphtheria, at a meeting of the Society of Medical Officers of Health last year, that special isolation schools, with treatment on open-air lines, might become necessary for the education and bacteriological supervision of the chronic carrier of diphtheria bacilli—a scheme comparable to the open-air schools long established and of proved value in the treatment and education of the tuberculous child.

*Susceptibility to diphtheria infection and its prevention.*

From the now well-known work which has been carried on for some years with increasingly satisfactory results in America by Park, Zingher,<sup>9</sup> Guthrie and others, much has been heard of the value of the Schick test as a means of detecting the susceptible school child. The test itself may be regarded as comparable to the Tuberculin test. The success of subsequent immunisation of the non-immune by graduated doses of the toxin-antitoxin mixture depends much on the source of the preparation used and its careful and accurate administration. The extensive experience forthcoming from the American workers encourages a hope of the possibility, even at some remote date, of application of the test and immunisation on a wide scale in England. There is already evidence in America of the reduction in incidence<sup>10</sup> and mortality of the disease, which may be attributable to increasing protection against diphtheria.

The mortality from diphtheria in New York City fell from :2 per 10,000 in 1920 to :16 in 1921 and :15 in 1922.

Hitherto in this country these measures have been in the experimental stage, mainly based on a few very thorough and convincing investigations which have been carried out by Dr. O'Brien and his co-workers<sup>11</sup> at the Wellcome Research Laboratories as well as by the Ministry of Health,<sup>12</sup> in institutions in London and the provinces, where alone close supervision of each inoculated child is at all possible as compared with those living at home and attending school.

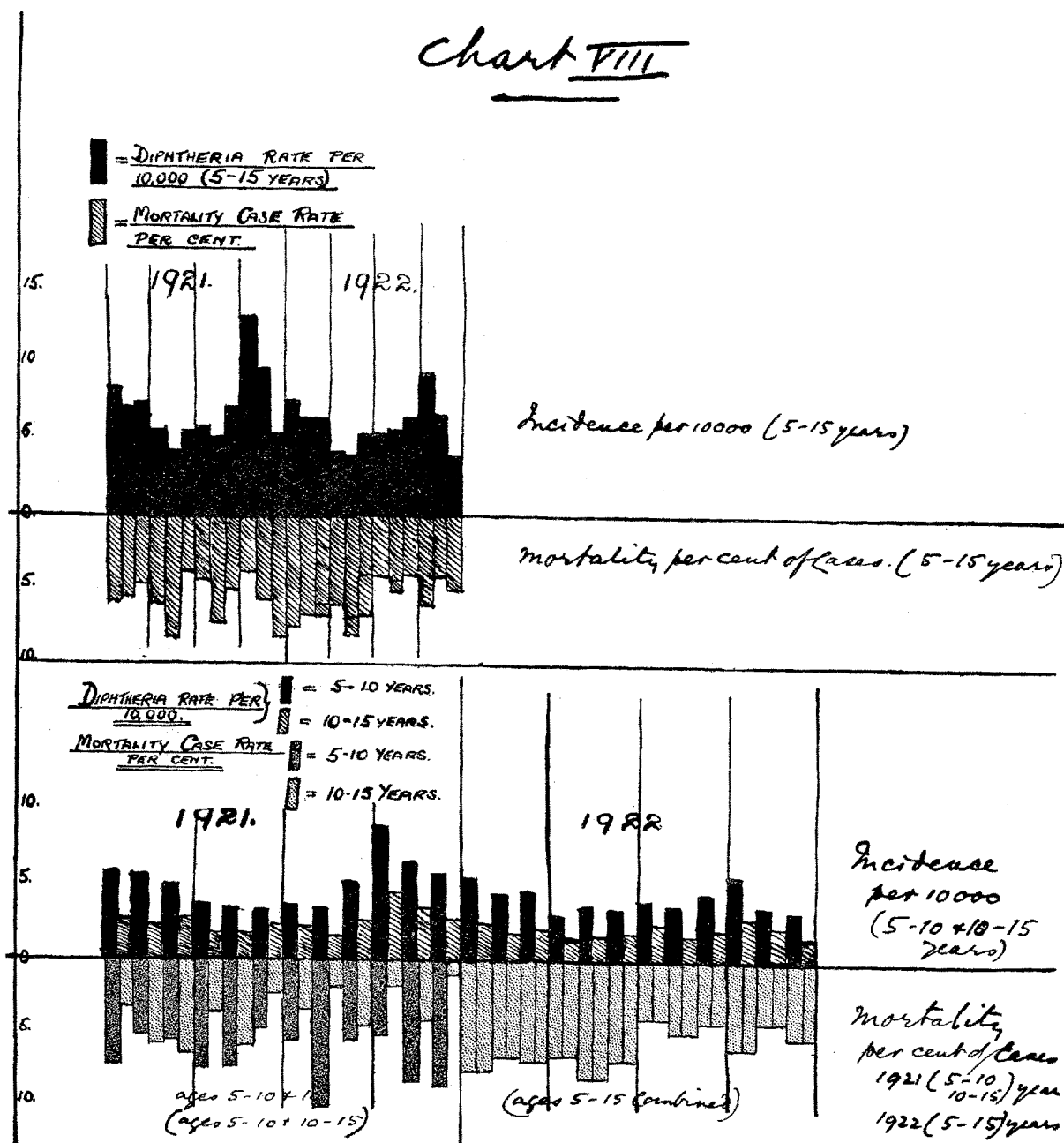
Mention must also be made of the recent valuable contribution on the subject by Surg.-Commr. S. F. Dudley, R.N. ("The Schick test, diphtheria and scarlet fever—a study in Epidemiology," published by the Medical Research Council, No. 75, February, 1923)—based on the testing of 831 boys of the Royal Naval School, Greenwich.

The Schick test has shown a high proportion of susceptible children up to the age of 5, also the interesting fact that in the poorer classes more children are immune than among the well to do. Owing apparently to less exposure to infection, the higher the social scale, the lower is the degree of immunity. Zingher<sup>9</sup> in 1921 examined 52,000 children by means of the test and found as great

a range of immunity as 80 to 84 per cent. in the poorer districts, 33 per cent. in good class schools and only 15 per cent. in a rural school.

Recent observations carried out on adults, in the case of hospital students at St. Bartholomew's Hospital,<sup>13</sup> shewed that of 157 persons tested only 34.4 per cent were immune, and of 23 nurses tested 43.4 per cent were immune. In time of epidemic it has been suggested that, owing to the high proportion of non-immune between the ages of 1 and 5 years, all children up to the age of 5 should be immunised without previously applying the Schick test and that the test should only be applied to adults and children over 5 years, with subsequent immunisation of those giving a positive result.

Chart VIII





Health propaganda and education of the public on the importance of such a means of prophylaxis, possibly as potent as vaccination against small-pox, might do much to gain a popular appreciation of the necessity of protecting the school child against a disease, whose mortality rate is still much too high, despite specific antitoxin treatment.

Although the request for material originally came from the Wellcome Research Laboratories, it must in conclusion be stated, that a debt of grateful acknowledgment is due to the Director and his colleagues, Drs. A. J. Eagleton and C. C. Okell, for the very valuable information provided by the results of virulence tests applied to cultures from school children during the past two years, and also for much helpful criticism in the preparation of this paper.

### SUMMARY.

#### I.—DIPHTHERIA IN LONDON, 1918-1922.

##### (a) ALL AGES.\*

Year.	Notified Cases.	Case rate per 10,000 population.	Diphtheria Deaths.	Case Mortality (per cent.)	Diphtheria Mortality per 10,000 population.
1918	8173	18.4	669	8.1	1.5
1919	9459	21.7	775	8.2	1.8
1920	13780	30.4	1023	7.4	2.3
1921	16319	36.4	1150	7	2.6
1922	15287	33.8	1137	7.4	2.5
Mean for 1908 to 1917	7760	17.4	588	7.58	1.3

##### (b) SCHOOL-AGE PERIOD (5-15 years).\*

Year.	Notified Cases.	Case rate per 10,000 estimated population at 5 to 15 years.	Diphtheria Deaths.	Case mortality per cent.	Diphtheria Mortality per 10,000 estimated population at 5 to 15 years.
1918	4146	50	233	5.6	2.8
1919	5293	64	348	6.6	4.2
1920	6499	80	439	6.7	5.3
1921	9089	112	495	5.4	6
1922	7352	92	420	5.7	5.3

##### (c) IN LONDON ELEMENTARY SCHOOLS.

Year.	Number of Reported Cases.	Average School Attendance.	Case rate per 10,000 of School Children.
1918	2910	604,353	48
1919	3365	591,967	56
1920	5841	624,436	93
1921	6661	625,017	106
1922	5641	616,206	91

### II.—SCHOOL INVESTIGATIONS.

#### Number of Schools visited for Special Diphtheria investigation.

1918	...	56	1921	...	281
1919	...	116	1922	...	259
1920	...	317			

\* From Registrar-General and M.A.B. returns.

#### Bacteriological Examinations of Throat, Nose and Ear of Children Swabbed in the Course of Special Visits (including re-examinations).

Year.	Total Examinations.	Negative per cent.	Suspicious bacilli. per cent.	B. diphtheriæ present. per cent.
1918	1382	1147=83	40=2.8	195=14.2
1919	2924	2194=75	262=9	468=16
1920	5811	4740=81.6	350=6	721=12.4
1921	6606	5541=84	419=6.3	656=9.7
1922	5401	4553=84.4	370=6.6	488=9

### III.—BACTERIOLOGICAL RESULTS, APRIL, 1921, TO MARCH, 1923.

No. of Examns. of Throat, Nose and Ear.	No. of Children Swabbed.
12,017	of 9,209
Negative in 10,139	of 8,020=87 per cent.
B. diphtheriæ present in 1,117	of 569=6.2
Suspicious diphtheroids in 771	of 620=6.8

#### EXAMINATIONS FOR ISOLATION OF B. DIPHTHERIÆ.

1,426 of 994 cases=10.8 per cent. of all children examined.

#### B. diphtheriæ Isolated in

641 examns. of 442 cases = 67.3 of total positives including 87 cases previously reported "Suspicious."

#### B. diphtheriæ not isolated in

206 cases=36.2 per cent. of those originally reported positive.

### IV.—RESULTS OF VIRULENCE TESTS.

Examns. (per cent.) Cases per cent.  
Virulent in 390 = (60) of 291 = 65.8  
Avirulent in 251 = (40) of 151 = 34.2

Total 641 442

#### COMPARE DR. EAGLETON'S SERIES, B.M.J., JAN. 28th, 1922.

Clinical cases of B. diphtheriæ Virulent  
Diphtheria ... in 100 per cent.  
Convalescents after diphtheria ... 90.9 "  
Carriers ... 38.8 "

### V.—RECORDS OF DEFECTS OF THROAT, NOSE OR EAR, OR HISTORY OF ILLNESS OR CONTACT WITH INFECTION, IN 423 OUT OF 442 CARRIERS.

#### (a) DEFECTS OF THROAT OR NOSE RECORDED IN

280 Carriers = 66 per cent.  
{ 190 Virulent = 68 "  
90 Avirulent = 32 " }

Otorrhoea, 3 cases (2 virulent, 1 avirulent).

#### (b) Record of History of Illness or Contact with Infection in 153 carriers=36 per cent.

(1) Previous history of diphtheria in 18 carriers:—13 virulent, 5 avirulent.

(2) History of recent scarlet fever in 4 carriers:—All virulent.

(3) History of sore throat, "illness" or cold in 57 carriers:—39 virulent, 18 avirulent.

(4) Home contacts of cases of diphtheria in 38 carriers:—27 virulent, 11 avirulent.

(5) Family history of sore throats or home-carriers in 17 school-carriers:—14 virulent, 3 avirulent.

(6) Desk contacts of diphtheria in school in 19 carriers: 14 virulent, 5 avirulent.

No history of contact with infection, no record of defects in 19 carriers:—10 virulent, 9 avirulent.

1921.

1922.

																				Serological Grouping of 70 tested strains of virulent K.L.B. from School Carriers (Types I. to X.)									

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- <sup>16</sup>Lancet, 1922, I., p. 372.
- <sup>17</sup>Report of the Medical Officer (Education) to the London County Council for 1909. No. 1367, pp. 68 and 69.
- <sup>18</sup>Report by Committee of Massachusetts' Association of Boards of Health—"Diphtheria in Well Persons." 1902.
- <sup>19</sup>Thomas, C. J., Brit. Med. J., Aug. 27, 1904. "School diphtheria in the Metropolis."

<sup>20</sup>Davies, D. S., Public Health, March, 1907, pp. 356 and 357. "Diphtheria and Small Pox."

<sup>21</sup>Macdonald, A. G., Lancet, Mar. 25, 1911, p. 795. "A Record of 90 Diphtheria Carriers."

<sup>22</sup>Councilman Mallory and Pearse, "Study of Bacteriology and Pathology in 220 Fatal Cases of Diphtheria," quoted by D. S. Davies. Public Health, March, 1907, p. 359. (Jl. Med. Research, 1901, V., 139 *et seq.*)

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## NOTES FROM BRANCHES.

## WEST OF ENGLAND BRANCH.

## THE ANNUAL MEETING.

There was an excellent attendance and a long programme admirably carried out at the Annual Meeting held at Bristol on July 19th. In accordance with the procedure suggested a year ago, the Vice-President was elected President for the ensuing Session and a new Vice-President chosen from the opposite end of the area, who will, in due course, succeed to the chair. Dr. Adkins, County Medical Officer for Devon, therefore, follows Surgeon Captain O. W. Andrews, R.N., in October, and Dr. Askins, School Medical Officer, Bristol, received a hearty invitation to the Vice-Presidency. The Branch is fortunate in being able to retain the services of Dr. Stirk as Secretary. The first meeting of the new Session will probably be held at Bristol.

## SMALL-POX AND DIPHTHERIA.

Two papers of considerable clinical interest were read, one by Dr. D. S. Davies on Small-pox, and the other by Dr. Peters on the Schick Test. Dr. Davies, speaking, of course, from a wide experience, gave some very valuable hints on diagnosis in connection with a disease which is much in our minds just now. He made special reference to the mild type prevalent in the West of England and in Gloucester. So impressed was the meeting with the importance of his remarks that requests were made for them to be printed and sent to all Branch Members. This has been done, and a very useful 4-page quarto circular is the result. Illustrations from photographs of two of the Gloucester cases are extraordinarily interesting, and should in themselves go far towards convincing anyone in doubt (if such a