DIPHTHERIA CARRIERS AND POST-SCARLATINAL DIPHTHERIA.

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THE theory that post-scarlatinal diphtheria is due to the spread of infection from diphtheria to scarlatinal wards—is, in fact, a true cross-infection—appeals, doubtless, to the lay public, but has little evidence to support it. There is, of course, always a possibility that a nurse, transferred from the care of diphtheria patients, may carry virulent germs in her throat and may become a source of infection in the scarlatinal wards, but that such an occurrence is exceptional is sufficiently proved by the facts observed in reference to post-scarlatinal diphtheria.

In the first place, it has been shown that hospitals which receive only scarlatina suffer almost as severely as those which admit both scarlatina and diphtheria. Thus, during 1896-98, the Northern Hospital received convalescents from both diseases, and had a post-scarlatinal diphtheria incidence of 4.9%. The Gore-Farm Hospital during the same period received only scarlatinal convalescents, and had a post-scarlatinal diphtheria incidence of 4.5%.*

Secondly, the development of diphtheria by a scarlatinal patient is, in the large majority of cases, a phenomenon of convalescence. Were it generally due to leakage of infection from other wards, it is reasonable to suppose that it would be equally common amongst acute cases. As a matter of fact, it is only after the patients have been allowed out of bed, and are enabled to come into intimate contact, that infection occurs.

It is obvious, then, that some other explanation than cross-infection must be found, and all evidence points to the most important cause of such outbreaks being the presence of a diphtheria carrier or carriers among the scarlatinal patients. That it is possible for an individual to retain diphtheria bacilli in his throat for a considerable period without showing any symptoms of the disease has, of course, been long recognised, and it appears that school children, who comprise the great majority of scarlatinal patients, are specially liable to act as carriers. The State Board of Health of Minnesota reports the discovery of carriers in percentages varying from 3 to 25% in schools more or less affected by diphtheria.*

Chapin quotes an instance recorded by Westbrook, in which 49% of healthy school children were found to be carriers of the diphtheria bacillus.*

Again, cases of scarlatina complicated by clinical diphtheria, or diphtheria wrongly diagnosed as scarlatina, may be the means of introducing infection into scarlatinal wards, but such cases, being generally recognised early, are of less importance than the insidious carrier.

A series of 420 unselected cases admitted as scarlatina was examined by Pugh, with the result that 4.5% were found to harbour diphtheria bacilli in their throats. Garrat and Washbourne found bacilli morphologically identical with *B. diphtheria* in 1.2% of 666 scarlatinal admissions, while Goodall, amongst 87 scarlatinal patients, found long diphtheria bacilli in the throats of 7%†

Between April 16th, 1910, and January 5th, 1911, I examined the throats of 1,000 patients admitted to the scarlatinal wards of the City Hospital, Edinburgh. In the large majority of cases, only one swab was taken from the throat of each patient. It cannot be claimed that such an examination is a searching one, or that any very great stress should be laid on its results. In the first place, a single negative result is of little value, and it would be necessary to obtain at least two successive negative swabs from throat and nose before declaring a patient free from bacilli. Such an examination, however, would have required much more time than I could spare, and even if performed would hardly have been conclusive. Newsholme has shown that six examinations have failed to detect *b. diphtheria* in the throat of an undoubted carrier responsible for a school epidemic.‡

Secondly, it is probable that many of the strains of diphtheria bacilli observed were avirulent. Again, it is well known that virulent diphtheria bacilli may adopt a form so atypical as to escape detection by ordinary microscopic methods. Lastly, it must be remembered that the throat of a patient in the early stages of scarlatina is by no means in its normal condition, and it seems quite possible that diphtheria bacilli, if present only in small numbers, may be temporarily "crowded out" by the more vigorously growing pyogenic organisms which constitute the flora of the scarlatinal throat.

Amongst the 1000 cases examined by me no fewer than 118 or 11.8% were found to

* "Bacteriology of Diphtheria." Nuttall and Graham Smith, 1908.

* "Sources and Modes of Infection." Chapin, New York, 1910.

† "Bacteriology of Diphtheria." Nuttall and Graham Smith, 1908.

‡ Newsholme. Arch. of the P.H. Lab., Univ. of Manchester, Vol. I., 1906.

harbour bacilli morphologically identical with *b. diphtheria*. In only two of those was the appearance of the fauces such as to suggest the probability of diphtheria. A special pavilion, consisting of two large wards and four isolation rooms, was set aside for such carriers, and they were not allowed to mix with other scarlatinal patients during their stay in hospital.

The age and sex distribution of the thousand cases examined is shown in table I. No marked preponderance of females is to be observed amongst the diphtheria carriers—12.4 % females to 11.06 % males,—but it is of some interest that in the age groups above fifteen there are 13.4 % female carriers to 6.6 % male.

TABLE I.

Age Periods.	Total Males.	Total Females.	Male Carriers.	Female Carriers.	Carrier Percentage.	Total Cases.
0-1	7	3	—	—	—	10
1-2	13	8	—	1	4.7	21
2-3	27	36	3	6	14.3	63
3-4	39	48	2	8	11.5	87
4-5	37	30	6	2	11.9	67
5-6	51	54	4	6	9.5	105
6-7	59	50	3	7	9.1	109
7-8	37	51	8	4	13.7	88
8-9	43	41	9	5	16.6	84
9-10	25	36	2	7	14.7	61
10-15	87	106	12	11	11.9	193
15-20	27	26	1	4	9.4	53
20 and over	18	41	2	5	11.8	59
Total	470	530	52	66	—	1000

In regard to age-distribution, the highest percentage of carriers is found between eight and nine years of age, and falls thereafter till

the twentieth year. If the cases be grouped in five-yearly periods, the percentage of carriers becomes 0-5 years=11.2 %, 5-10 years=12.3 %, 10-15 years=11.9 %, 20 years and over=11.8 %.

In order to discover whether any relationship could be demonstrated between the number of carriers admitted to the scarlatina wards and the amount of diphtheria occurring in their respective districts, a "spot map" of the city was prepared, showing the localities yielding diphtheria, scarlatina and "diphtheria-carrier scarlets" during the period under review. No such connection could be shown. The city of Edinburgh is divided into sixteen wards, and the percentage of "diphtheria-carrier scarlets" from the eight wards where diphtheria was most prevalent was only 0.6 % greater than that from the eight wards where it was least prevalent.

On the other hand, there does appear to be some reason for believing that a seasonal relationship may be traced between the two conditions (see table II.) As the number of carriers admitted during any given month was

TABLE II.

Seasonal Curve of Diphtheria Admissions and Scarlatinal Diphtheria Carriers, plotted by Bloxam's method.

Solid line—Percentage of total diphtheria (May—December) at each month.

Dotted line—Percentage of carriers among scarlet of the month.

small, and as the diphtheria figures were influenced by a localised epidemic occurring towards the end of the year, the curve has been plotted according to Bloxam's method—i.e., the terms instead of being stated as *a, b, c*, etc., are shown as:—

$$\begin{array}{ccc} \frac{a+b+c}{3} & \frac{b+c+d}{3} & \frac{c+d+e}{3} \end{array}$$

etc. The solid line represents the monthly percentage of diphtheria, and the dotted line the percentage of scarlatina cases harbouring diphtheria bacilli, calculated according to this method. It will be seen that both curves rise towards the end of the year, but whether there be any real connection between them could only be determined by experiments lasting over a series of years.

The results obtained by the system adopted—the isolation on admission of all scarlatina cases found to be carriers of the diphtheria bacillus—have proved, I must admit, rather disappointing. Of the 882 cases among whom bacilli were not detected on admission, no fewer than 3.9% were discovered to be positive at some period of their stay in hospital, while 1.8% were diagnosed as post-scarlatinal diphtheria on clinical and bacteriological grounds. The latter figure is, of course, not excessive, but is somewhat higher than what we have been accustomed to during the past six years. It is decidedly unfortunate that the year during which special precautions were taken should be associated with less satisfactory results, but there are certain points to be considered before condemning the system. First, the admitted insufficiency of the examination on admission, and the fact that one carrier, inadvertently overlooked, may be responsible for a considerable number of cases in the convalescent wards. Second, that diphtheria in Edinburgh during the past year has been distinctly more severe in type, and, if judged by the number of multiple house infections and cases in which the source of infection could be clearly traced, of a higher degree of infectivity than from some years previously. In fact, I think it possible that had special precautions not been taken, post-scarlatinal diphtheria cases during this year might have been much more numerous. Certainly the plan of isolating all detected carriers appears, at least, a reasonable one, and I am convinced that, if employed for a number of years, would prove to be of service

in protecting the scarlatinal convalescent from the risks of a second infection.

I have to thank Dr. C. B. Ker for permission to publish those results.

THE MEDICAL EXAMINATION OF DRIVERS OF MOTOR VEHICLES.—The Metropolitan Police Authorities have informed the proprietors of mechanically propelled vehicles in London that in future all applicants for licenses to drive public service motor vehicles must pass a medical examination or produce a medical certificate as to physical fitness.

THE INCREASE OF VACCINATION EXEMPTIONS.—The President of the Local Government Board, in answer to a question in the House of Commons on July 4th, gave the following statistics:—

Year.	Births.	Vaccinations.	Exemptions.
1903	948,271	714,637	37,675
1904	945,389	711,504	40,461
1905	929,293	705,040	44,369
1906	935,081	686,992	53,828
1907	918,042	651,050	76,709
1908	940,383	594,792	160,350
1909	914,472	547,251*	197,326*

* These figures are approximate and liable to correction.

BELETED ANNUAL REPORTS.—At the last meeting of the Gloucestershire County Council the Public Health and Housing Committee reported that 15 out of the 35 district medical officers of health had not yet sent copies of their reports to the County Council under Section 19 (1) of the Local Government Act, 1888, although such reports should have been made up to the end of December and forwarded to the County Council within three months; and as the delay prevented the preparation of the county medical officer of health's annual report, embodying a summary of the district medical officers' reports, the Committee recommend the County Council to intimate to the defaulting District Councils that they (the County Council) would refuse to pay the contribution towards the salary of their medical officers, in accordance with the power contained in the before-mentioned section. This was agreed to.

THE NEGLECT OF VACCINATION.—The annual report of the school medical officer, Scarborough, states that no less than 55 per cent. of the school children examined last year were unvaccinated.