COMBINED INQUIRY INTO THE PRESENCE OF DIPHTHERIA AND DIPHTHEROID BACILLI IN OPEN WOUNDS.

By COLONEL J. G. ADAMI, MAJOR F. B. BOWMAN, CAPTAINS F. ADAMS, A. G. FLEMING, C. D. FARQUHARSON, C. IMRIE, and R. M. JANES, C.A.M.C.

THERE appeared in the *Journal of the American Medical Association* for September 8, 1917, an article by Majors J. G. Fitzgerald and D. E. Robertson of No. 2 Military Division, Canada, entitled "Report of an Outbreak of Diphtheric Wound Infection among Returned Soldiers." These observers report that as the result of a thorough investigation of all infected wounds in returned men of the C.E.F. in their Division, carried out between May 20 and June 7, 1917, no less than forty out of sixty-seven cases afforded cultures of *B. diphtheriæ*. They admit that in some cases the infection may well have been conveyed from case to case by a nurse whose duty it was to dress the suppurating amputation cases. This nurse was found to have a slight wound of the index finger which yielded cultures of *B. diphtheriæ;* particulars are given which indicate that she may have distributed the infection from wound to wound. That she could not be held entirely responsible for the outbreak is shown by the fact that other cases with infected wounds showed themselves in soldiers who had returned to Canada after the nurse had been taken off duty and sent to the Isolation Department; two or three cases were discovered in men immediately upon their arrival in Toronto from overseas. And the authors conclude: "It was extremely probable, therefore, that patients with diphtheric wound infection were being returned to Canada from overseas."

The extraordinarily high proportion of positive cases affording cultures of the diphtheria bacillus from wounds in this outbreak is undoubtedly calculated to afford the impression that infection of open wounds with *B. diphtheriæ* is a common, not to say widespread, condition in military hospitals overseas. That the characteristic membrane formation occurred in certain of their cases, but not in all, is evident from their description and illustrations. From that description it is equally evident that in some cases the existence and isolation of virulent Klebs-Loeffler bacilli was proved by inoculation experiments. Their paper would have been more complete had precise figures been given regarding these matters. One of the two authors is a bacteriologist and serologist of distinction, Director of the Serological Institute of the University of Toronto, to the activities of which, in the preparation of antitoxins and vaccines, the Canadian Expeditionary Force and Canada at large is heavily indebted. Of the existence of the epidemic in Ontario in 1917 there is no doubt; that there were cases of infection of wounds with virulent diphtheria bacilli and membrane formation is not disputed. The fact that some of the cases are reported to have afforded cultures of the diphtheria bacillus immediately upon arrival in Toronto from overseas, rendered it essential that in England an inquiry be set on foot to determine the frequency of the presence of *B. diphtheriæ* and allied diphtheroids in the wounds of patients in Canadian military hospitals.

To our knowledge no such investigation on an adequate scale has hitherto been attempted. It is not an easy matter, but on the contrary demands much laborious work on the part of the bacteriologist, and when it is remembered that in hospitals of 1,500 to 2,000 beds the daily routine is in itself sufficient to occupy fully the time of the laboratory staff, the additional work thrown upon that staff by an investgation of this order is no light matter. It is not sufficient to make smear cultures from the wounds upon Loeffler's blood serum, and to call any granulated bacteria diphtheria bacilli, and that because non-toxic diphtheroids may be present in wounds and may grow equally well upon "Loeffler," and, what is more, in general when stained may show the palisade arrangement and the metachromatic granules that used to be regarded as characteristic of the Klebs-Loeffler bacillus. All such bacteria have next to be gained in pure culture, and put through their paces on media containing different "sugars." This will throw out all the diphtheroids. But even this is insufficient. There are strains which morphologically and by fermentation tests conform wholly with the *B. diphtheriæ*, but are absolutely harmless. It is necessary with every strain answering to the properties of the *B. diphtheriæ* to conduct inoculations upon the guinea-pig, thereby to determine whether it is harmless or pathogenic, or if such a course be regarded as a "counsel of perfection" this must be laid down, namely (1) that in the absence of clinical signs no bacillus can be accepted as the genuine Klebs-Loeffler bacillus without the confirmatory proof of inoculation, and (2) that where in a wound there is glazing and membrane formation, inoculation must be employed to demonstrate that this is due to the diphtheria bacilli present, and not to the *Micrococcus aureus* or other organism; when this has been proved, then other cases in the ward showing membrane formation may reasonably be diagnosed as diphtherial from microscopical and cultural findings without the test of inoculation.

Early in August information regarding the outbreak in No. 2 Military Division was forwarded by the D.G.M.S., Ottawa, to the D.M.S. Canadians, and the A.Ds.M.S. in England were advised and asked to issue the necessary instructions for a bacteriological examination of all open suppurating wounds in Canadian hospitals (A.M.D. 25-1-5 of August 10, 1917). If the number of cases in any area was very large, it was held sufficient that every alternate case be examined. So also it was asked that the personnel of the hospitals be examined to determine the existence of diphtheria "carriers." Subsequently in the Shorncliffe area this examination for carriers was restricted to a group of the larger hospitals, active and convalescent.

"CARRIERS."

As regards carriers, the outcome of the investigation was to demonstrate a striking absence of carriers among the personnel of the different hospitals. Most hospitals report "all negative." The pathologists at Eastbourne and Orpington (Captains Douglas and Imrie) afforded nominal rolls of the personnel examined. At the former hospital cultures from the throats of 157 officers, N.C.Os., nursing sisters, and men yielded no Klebs-Loeffler bacilli, and only three growths of diphtheroids; three out of thirteen patients examined yielded diphtheroids (no *B. diphtheriæ*). Similarly from Orpington the report showed 111 of the personnel examined, not a single culture obtained of the Klebs-Loeffler bacillus, but twenty-four throats yielded Hofmann's bacillus (the common diphtheroid of the throat).

INFECTION OF WOUNDS. PRELIMINARY OBSERVATIONS.

The replies regarding the bacteriological examination of suppurating wounds were not so complete. Many hospital laboratories were not in the position to carry out the investigation, they were not equipped for an investigation on so extensive a scale, nor had they the requisite staff to carry it out in addition to the insistent routine work. Captain Fleming, pathologist at the Duchess of Connaught Canadian Red Cross Hospital at Taplow, reported that for some little time in connection with the Carrel-Dakin and Flavine treatment of wounds they had conducted a routine examination, with cultures, of all suppurating wounds, and had never encountered *B. diphtheriæ*. Captain T. R. Little reported from the Central Laboratory at Hastings that few cases with suppurating wounds came into the hospitals of that area; he had made a full bacteriological examination of six cases, of which four yielded diphtheria-like organisms. 0·5 c.c. of a standard suspension of a twenty-four-hour culture of *B. diphtheriæ* inoculated into guinea-pigs or young rabbits will cause death within seventy-two hours. Taking these four cultures he had inoculated with 0·5, 1·0 and 1·5 c.c. of suspensions of each into young half-grown rabbits, and not one of them had succumbed. It deserves note that prior to the War Captain Little had been engaged upon a study of the diphtheroids.

COMBINED INVESTIGATION.

Here the matter rested until the appearance of the paper above-mentioned by Majors Fitzgerald and Robertson, when the D.M.S. Canadians directed that at the Central Laboratory, Folkestone, and at Nos. 4, 15 and 16 Canadian General Hospitals, a combined investigation be made into the matter of the infection of open wounds by members of the diphtheria group. At these centres it was considered that conditions were such, both as regards the nature of the cases admitted and the laboratory accommodation, as to afford the most favour-