CUTANEOUS DIPHTHERIA

Epidemiological and Dermatological Aspects of 365 Cases amongst British Prisoners of War in the Far East

BY

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Prisoner-of-war Camps boast an unenviable reputation for the production of virulent disease in epidemic form. This infamous and unhappy notoriety was in no way diminished by experience in the Far East during the recent war. It is, however, as pointed out by Livingood and his associates (1946), one of the compensations of war that an opportunity is afforded physicians to study certain diseases which tend to occur in epidemic proportions amongst military personnel. Such a disease they rightly count cutaneous diphtheria. My present paper deals with an outbreak of this disease of alarming proportions and peculiar design amongst British Prisoners of War in Japanese Camps on Singapore Island during the period February 15, 1942 to February 14, 1943.

It will hardly be necessary to point out that the circumstances of prisoner-of-war existence precluded any possibility of investigating the cases along the lines which I would have wished. Even the keeping of such records as were achieved was a difficult problem, for, as my notes on the increasing numbers of cases grew larger, the necessity to condense them ever further to reduce bulk and minimize the constant risk of summary confiscation became increasingly pressing. This unhappy circumstance, allied to our other difficulties, accounts for the failure to record much that might have proved of both interest and importance. It was possible, however, to preserve certain data regarding epidemiological conditions, predisposing factors, the morphologic characteristics of the cutaneous lesions and their course. Brief reference will also be made to complications, but it is hoped to publish at a later date fuller details of the cardiovascular and neurological findings.

While the diagnosis and management of isolated cases of cutaneous diptheria probably falls within the experience of an appreciable proportion of physicians in this country the development of extra-faucial diphtherial lesions on an epidemic scale has been much less common. Indeed, so far as I am aware, only one small outbreak of cutaneous lesions has been described as occurring within the United Kingdom since 1749 when Starr reported

1 Having seen, at a later date, the conditions at Changi and many other Prisoner of War camps on the Island and elsewhere, it is with appreciation of the difficulties and even risks involved and with admiration of the professional ability and tenacity which, in the face of completely unsympathetic Japanese control and interference, maintained these records, that we now most gratefully accept and publish this account.—Ed.
numbers of extra-facial infections during an epidemic of the angina maligna in Cornwall. The outbreak in question is that of Williams (1943) who experienced in an epidemic of 37 cases of diphtheria amongst troops in England, 17 faecal infections, 1 anterior nasal case and 19 instances of cutaneous and/or conjunctival diphtheria. All other reported epidemics of cutaneous diphtheria appear to have been encountered in tropical or sub-tropical countries although outbreaks of true wound diphtheria have arisen not infrequently in temperate climates.

It may therefore be of interest, before proceeding to describe the epidemic which fell to my experience, to review briefly the history of extra-facial diphtherial infections, particularly in so far as they have occurred in epidemic proportions. The history of non-respiratory localizations may be traced with certainty back to the 1700s, which century produced accounts of cutaneous diphtheria from Starr in Cornwall (1749), from Chomel in France (1759) and from Bard in New York (1771). Bretonneau (1821–1826) and Trousseau (1830–1835) both furnished extensive observations on the diagnosis and prevention of the disease and following their teaching cutaneous localizations became much less frequent. Neisser (1891) appears to have been the first observer to recover the organism from a cutaneous lesion, but it was not until the 1914–1918 War that reports on large series of extra-facial infections began to appear. Craig (1919), reporting the results of his investigations into the aetiology of the desert or veldt sore, a major cause of sickness and disablement afflicting our troops in the Middle East Theatre of War in 1914–1918, succeeded in obtaining positive cultures of the Klebs-Loeffler bacillus in 129 out of 197 cases (65.5 per cent). The work of Walshe (1917, 1918, a and b) in the field of post-diphtheritic paralysis confirmed Craig’s fundamental findings and further support for these views derives from studies in the same territory during the recent war. (Cameron and Muir, 1942; Cameron, 1943; MacGibbon, 1943.) In the field of wound diphtheria World War I furnished reports on large numbers of cases. (Fitzgerald and Robertson, 1917; Simons, Wearn and Williams, 1921; Simmons and Bigelow, 1919; Hartsell and Morris, 1919; Landow, 1923.)

Between the two Great Wars only Bensted (1936), on the North-West Frontier of India, appears to have encountered an epidemic of extra-facial localizations but the coming of the recent conflict saw a revival of the onetime considerable interest in cutaneous diphtheria in the literature, with reports from the Middle East Theatre of War on a total of 78 cases (Cameron and Muir, 1942; Cameron, 1943; MacGibbon, 1943), from Burma on 140 cases (Livingood et al., 1946), and from the South Pacific on 174 patients (Liebow et al., 1946).

**Epidemiological Conditions**

The epidemic of diphtheria amongst the Prisoners of War on Singapore Island, which I now describe, remarkable though it proved to be in many respects, presented one feature which alone sufficed to set it aside as bizarre—
namely the occurrence of cutaneous diphtheritic lesions in 365 or 37·8 per cent of 964 cases of diphtheria. My account relates primarily to those 365 patients. The figures include all cases admitted to the Isolation Wards as diphtheria and accepted as such. It must, be emphasized that an unknown, possibly considerable number of mild, atypical cutaneous cases almost certainly pursued a clandestine existence. This doubtless also applied, although to a lesser extent, to mild nasal and faucial infections. In addition the Japanese might on occasion refuse the transfer of a case from outlying camps on the Island. Such cases were consequently lost from the record.

Numbers of my colleagues and fellow prisoners have written vividly and fully on life and conditions in Japanese Prison Camps. (Cruickshank, 1946; Burgess, 1946; Dunlop, 1946). It is therefore necessary to proffer here only the briefest account of the general background.

The men who were to be the victims of the sweeping ravages of so many virulent infections were taken prisoners during February 1942 after a short but difficult and disastrous campaign. Conditions in the main Camp at Changi and in other camps were little short of appalling. Overcrowding was of gross degree, some thirty-two thousand British and fifteen thousand Australian Troops being crammed into barracks designed to accommodate a British garrison of five or six thousand. Sanitation and water supplies presented grave difficulties. Bacillary dysentery quick to seize a unique opportunity rose most magnificently to the occasion, sweeping through the camp in a fury of destruction, to leave a population weakened and despoiled by its passage and fearful of its return.

The diet comprised the very poorest type of Asiatic fare. Grossly deficient in protein, fats, vitamin B₃ and the B₂ complex as it was, disaster seemed inevitable. Deficiency of other essential elements was considered probable but less significant. The gloomy predictions of our nutritionists were soon realized. Beri-beri in all its forms became common in May, June, July and August 1942, while B₂ complex deficiency reared its head mainly in July and August 1942, first in the form of angular stomatitis, glossitis and scrotal dermatitis. but later as spastic paraplegia, retrobulbar neuritis and other so-called pellagroid syndromes. About October 1942 conditions began to improve somewhat and those deficiency syndromes although still prevalent, became for the time being rather less frequent and certainly less severe.

The grim spectre of diphtheria heralded its approach in soft but certain tones. Five cases of faucial diphtheria declared themselves during March 1942. From that point onwards the infection advanced steadily in ever-increasing strength. It was, however, not until July that a notable rise in the admission rate occurred. The following month the storm broke in all its fury. September saw the epidemic reach its peak with 295 admissions for all forms of diphtheria. The slight fall which occurred in October was succeeded by a rapid decline until February 1943 when the infection had receded to a more or less endemic state.

Recognition of cutaneous diphtheria in its acute stage was delayed until
August 1942, but once established it pursued a course roughly parallel to the main epidemic. The cutaneous localizations fell into two main and distinctive categories—scrotal diphtheria 167 cases, and cutaneous diphtheritic ulcerations 198 cases. The monthly admissions tabulated within these two essential categories are set out in Table I, p. 68, while the graph, p. 69, represents in diagrammatic form the progress of the epidemic.

The unfolding of the story of extra-faucial diphtheria can be most readily seen by reference to the table and graph. Perhaps the most significant epidemiological point is, that, although the table covers a period of one year no single case exhibiting an extra-faucial lesion was recognized during the first six months of this period which nevertheless produced 85 cases of pharyngeal and nasal diphtheria with nine deaths. It is, however, of note that as early as March 1942 Major P. R. Graves, R.A.M.C., O.C. Medical Division had recognised a case of post-diphtheritic paresis presenting in which the only causal lesion appeared to be a cutaneous one. 4 other such cases emerged in April and July. I am indebted to Major Graves for the following notes on these 5 cases. “Blurring of vision occurred in 3 cases; weakness and hoarseness of the voice in two cases; a transient left facial paresis in one case and typical peripheral neuritis in all 5 cases.” The original cutaneous lesions had been diagnosed “ulcerative dermatitis,” in 3 cases; “infected traumatic wound” in 1 case; and “infected burns” in 1 case.

These observations are useful in permitting at least a tentative reconstruction of the epidemiological sequence. First came a phase of virulent faucial diphtheria associated no doubt with a steep rise in the carrier rate. During this phase cutaneous cases were not recognized although their clandestine occurrence in atypical forms is evidenced by the 5 cases of post-diphtheritic paresis presenting which subsequently emerged. There followed a phase of peak prevalence for both respiratory and non-respiratory infections, the latter being of such a nature and such severity as to compel recognition of their true aetiology. The increased prevalence of the pure pharyngeal infection in this phase was, as might be anticipated, linked with a notable fall in the case fatality rate in this type of case from 10·38 per cent for the first five months to 4·6 per cent for the next three months. The third and final phase was of course that of declining prevalence and virulence.

That large-scale epidemics of extra-faucial diphtherial lesions have tended to appear chiefly after the establishment of an even more extensive outbreak of respiratory localizations is neither a new nor a recent observation. This train of events is to be traced in the epidemics of Craig (1919), Cameron and Muir (1942) and Williams (1943), in all of which the cutaneous cases were associated with considerable numbers of faucial and nasal infections. This sequence is, however, strikingly absent in the epidemics encountered in Burma (Livingwood et al., 1946) and in the South Pacific (Liebow et al., 1946). In both these outbreaks the local native population is indicted as the reservoir of infection.

Nevertheless civilian experience affords ample evidence that wide dissemina-
<table>
<thead>
<tr>
<th>Month</th>
<th>Purpur</th>
<th>Scrotal and ules</th>
<th>Scrotal and nasal</th>
<th>Scrotal and labial</th>
<th>Deaths</th>
<th>Pure</th>
<th>Ulcer and nasal</th>
<th>Ulcer and faucial</th>
<th>Ulcer and labial</th>
<th>Deaths</th>
<th>Labial, nasal, faucial and post-diphtheritic ulcerations presenting, etc., etc., etc., etc., etc.</th>
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<td>28</td>
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<td>½ Feb.</td>
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<tr>
<td>Totals</td>
<td>99</td>
<td>10</td>
<td>36</td>
<td>17</td>
<td>5</td>
<td>12</td>
<td>186</td>
<td>3</td>
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<td>4</td>
<td>599</td>
<td>35</td>
<td>964</td>
<td>51*</td>
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<tr>
<td>Total Cases</td>
<td>167</td>
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<td>599</td>
<td>198</td>
<td>599</td>
<td>964</td>
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</table>

* Plus three deaths not attributable to diphtheria.
tion of the specific organism of diphtheria will rarely in itself suffice to precipitate large numbers of extra-faucial cases in a European population containing a suitable proportion of non-immunes. Other factors must also be at work. Most important amongst these factors is undoubtedly the integrity of the cutaneous surface. Trousseau first enunciated the dogma that diphtheria never "developed itself on the skin unless it was previously deprived of its epidermis or ulcerated." Craig (1919) expresses the view that "The common occurrences of diphtheritic skin lesions under tropical conditions may be explained:

(a) by moistness of the skin and activity of the sweat glands, soddenness of epithelium providing an opportunity for entrance of bacilli and a suitable medium for their multiplication.
"(b) by the environment of the troops—close contact between man and man, lack of washing facilities and constant liability to laceration of the skin."

Livingood and his associates (1946) considered that the following conditions must be operative in order to produce an epidemic of cutaneous diphtheria:

1. A significant proportion of susceptibles.
2. A hot humid climate or a desert climate.
3. A source of infection.
4. A combination of circumstances which makes for multiple superficial traumata to the skin, poor personal hygiene and close personal contact.

With these views my experience was wholly in accord, although I would insist that more than a source of infection is necessary but rather a reservoir of infection whether this be a concurrent outbreak of respiratory diphtheria or a widespread prevalence of cutaneous diphtherial lesions in local native populations. The various and complex predisposing factors detailed in (4) above really amount in aggregate to a peculiarly vicious environment likely to arise only amongst personnel engaged in active field combat or placed in circumstances of grave destitution, waging an incessant fight with squalor, filth, hopelessness and degradation in tropical and sub-tropical climates.

On no occasion was I able to establish that the specific virus of diphtheria had breached the intact unabraded skin which apparently presented an insuperable barrier to the disease. The predisposing lesions proved to be of diverse origin and their nature is fully discussed in relation to the various localizations of the membrane.

It is necessary to point out, however, that Cameron and Muir (1942) differentiating their cases into acute and chronic sores, found the former variety always associated with a positive lesion of the throat or more commonly the nose occurring both on unbroken skin and at the sites of previous trauma. The chronic sore on the other hand they found to be invariably superimposed on a pre-existing skin lesion. Livingood (1946) also admits that a significant percentage of patients did not give a history of a perceptible pre-existing lesion. It would therefore appear that attack on the unabraded skin may at times succeed.

The part played in the spread of these infections by improper technique in carrying out dressings at Unit Medical Inspection Rooms was difficult to assess. It is an aspect heavily underlined by Bensted (1936). Under prisoner-of-war conditions, shortage of antiseptics and difficulties in sterilization render it hard to ensure that all necessary precautions are rigidly followed. Many extra-facial lesions must have been clandestine, thereby providing a most dangerous source of infection.

The population at risk in the Camps lay very largely in the age-group 20–25 years. Such a population might, according to Topley and Wilson (1931), be expected to contain 11–12 per cent of Schick-positive reactors. On the other hand Bensted (1936) found 27 per cent of non-immunes amongst a battalion of troops. In this connexion it is to be borne in mind that con-
gregations of troops, especially County Regiments, are likely to contain a considerable proportion of men from rural areas, which might well result in an usually high percentage of Schick-positive reactors in relation to age. It is not without interest that, when in December 1943, by which time diphtheria had all but disappeared, I was able to carry out Schick tests on 50 prisoners of war selected at random, 46 were negative and 4 were very faintly positive. Those 4 were rapidly converted to the Schick-negative state by a single dose (1 c.c.) of toxoid antitoxin floccules. The absence of a single well-marked positive reactor even in so small a series of 50 tests and the promptness of the response to a single dose of toxoid in the mild positives might at least be considered to give some credence to the concept that the infection spent itself by the method of almost total exhaustion of susceptibles in a relatively closed community.

The size of our population I could not accurately record from day to day. At the commencement of our captivity the British prisoners numbered approximately 32,000 but from that point onwards this figure was subjected to continual increases and decreases as parties of troops were moved in or were despatched to Camps on the Mainland of Malaya and Burma. As departures were in excess, the numbers of men had fallen by about one-half in February 1943. No doubt this circulation of population was not unimportant in maintaining the epidemic pot boiling. During 1943, although emigration continued, immigration almost ceased so that our community became a relatively closed one.

Diphtheria in Malaya is a rare disease. Accordingly when, in July 1942, the care of these cases became my responsibility an attempt to trace the beginnings of the epidemic was made. After a lapse of three and half months the necessary information was somewhat difficult to obtain, but the finger of suspicion pointed relentlessly to an English County Regiment which had landed in Singapore from England at the end of January 1942. All the early cases occurred in this unit or its immediate contacts. It is a far cry from the shores of England to prisoner-of-war camps in Malaya, but it is more than a little probable that the infection successfully negotiated a journey of some 11,000 miles to unfold its deadly potentialities.

**Bacteriology**

Any consideration of cutaneous diphtheria must hinge largely on diagnostic criteria and here it was that the greatest obstacles to proper study of the cases lay. Our diagnostic armamentarium boasted:

1. **Direct Smears:** The limited potentialities of this method were well recognized and it was employed very rarely.

2. **Culture:** As we did not possess the usual media, Major Roy Maynard, Australian Army Medical Corps, employed a medium comprising agar enriched with egg albumen, peptone and serum. An excellent growth was obtained although rarely in pure culture and the organism readily identified. Identification was in all cases by skilled bacteriologists. In
Cutaneous Diphtheria

A considerable proportion of cases, the morphology of the organisms isolated suggested a gravis strain but it was not possible to pursue this line of investigation.

For the purpose of virulence tests we possessed no suitable experimental animal. The only animal which we were in a position to consider was the rat and the relative immunity of this creature has been amply confirmed (Topley and Wilson, 1931). Virulence tests being beyond our resources, this attribute of the organism must be inferred from the mortality, the incidence of myocarditis and the incidence of paresis. Notwithstanding the lack of animal inoculation as tests of virulence the evidence indicates beyond all reasonable doubt the existence of a large number of extra-faucial lesions actively infected with virulent strains of the Corynebacterium diphtheriae.

These then were the general principles upon which diagnosis was based. It is necessary to emphasize that there existed in every case a local lesion on which there was implanted a highly probable diphtheritic infection. It will be realized that with increasing experience the clinical appearance of these lesions acquired an increasing diagnostic significance. On the bacteriological side, amongst the 167 cases of scrotal diphtheria a positive culture for the Corynebacterium diphtheriae was obtained in 125 instances (74.8 per cent). In one case cultures were repeatedly negative but the diagnosis was maintained and the case subsequently died. In 41 cases no cultures were taken. Of those, 8 died and 12 developed evidence of the cardiovascular and neurological complications peculiar to diphtheria. In the 68 scrotal cases exhibiting a second diphtherial localization positive cultures were obtained from this lesion in 44 examples: lips 3 cases, nose 26 cases, fauces 8 cases, cutaneous diphtheritic ulceration 7 cases.

<table>
<thead>
<tr>
<th>Type of case</th>
<th>No. of cases</th>
<th>Culture positive</th>
<th>Culture negative or omitted</th>
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<tbody>
<tr>
<td>Pure scrotal diphtheria</td>
<td>99</td>
<td>88</td>
<td>11</td>
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<tr>
<td>Scrotal and nasal diphtheria</td>
<td>36</td>
<td>Scrotum 19</td>
<td>Nose 26</td>
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<tr>
<td>Scrotal and faucial diphtheria</td>
<td>17</td>
<td>Scrotum 7</td>
<td>Fauces 8</td>
</tr>
<tr>
<td>Scrotal and labial diphtheria</td>
<td>5</td>
<td>Scrotum 4</td>
<td>Lips 3</td>
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<tr>
<td>Scrotal and ulcers</td>
<td>10</td>
<td>Scrotum 7</td>
<td>Ulcers 7</td>
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<tr>
<td>Totals</td>
<td>167</td>
<td>Scrotum 125</td>
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Amongst the 198 cases exhibiting cutaneous diphtheritic ulcerations a positive culture for the Corynebacterium diphtheriae was obtained in 156 cases while in 10 further cases direct smears were reported positive. Bacteriological
confirmation was thus forthcoming in a proportion of 83.8 per cent of cases in this category. In the 12 cases of cutaneous diphtheritic ulceration with additional localizations confirmatory culture was forthcoming from the second lesion in 8 cases—nasal 2; faucial 5; labial 1.

### TABLE III.—BACTERIOLOGICAL RESULTS IN CUTANEOUS DIPHTHERITIC ULCERATIONS

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<th>Culture negative or omitted</th>
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<td>186</td>
<td>147 (plus 10 positive on direct smear)</td>
<td>29</td>
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<td>Cutaneous diphtheritic ulceration and nasal diphtheria</td>
<td>3</td>
<td>Ulcers 3</td>
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<td></td>
<td></td>
<td>Nose 2</td>
<td>1</td>
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<td>Cutaneous diphtheritic ulceration and faucial diphtheria</td>
<td>7</td>
<td>Ulcers 6</td>
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<td>Fauces 5</td>
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<td></td>
<td>Lips 1</td>
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<tr>
<td>Totals</td>
<td>198</td>
<td>Ulcers 156+10</td>
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<td>Other localizations 8</td>
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Thus in 365 cases exhibiting a cutaneous diphtherial localization the specific infection was corroborated by the bacteriologist in no less than 291 instances (79.7 per cent). In 74 cases culture was either omitted or reported negative but of those no less than 9 died and a further 12 developed evidence of the cardiovascular and neurological complications peculiar to diphtheria. The ease with which a positive culture was obtained varied somewhat in the different types of case. In scrotal diphtheria a positive report was very frequently forthcoming at the first attempt and generally, with the rarest of exceptions, the organism could be found in not more than three successive attempts. In the cutaneous ulcer case the position was somewhat different. Repeated cultures were frequently necessary and one or two negative reports were of little significance. This was particularly so where the lesion was fairly old or where antiseptic dressings had been applied. However, a saline dressing for a few days did not retard progress and a positive result could usually then be achieved. In addition it was quite futile to take swabs from the surface of these ulcers—the swab must be insinuated into the depths if a true result is sought.

**Scrotal Diphtheria**

Encountering scrotal diphtheria for the first time I had thought that I was dealing with a previously unknown localization—this is, however, not so. Amongst the earlier writers Trousseau (1830) has described instances of the characteristic membrane appearing on excoriations of the scrotum. In more recent times Martin (1928) reports a case in which pure cultures of the diphtheria bacillus (and positive virulence tests) were obtained from an abscess of the tunica vaginalis, while Cameron and Muir (1942) illustrate an acute
Cutaneous Diphtheria

diphtheritic scrotal ulcer—in this instance an acute contact infection of the previously unabrased skin of the right side of the scrotum exactly opposite a lesion on the right thigh.

Gangrene of the scrotum is a somewhat rare condition, the bacteriology of which presents a very variegated picture (Dodson, 1944). Nevertheless I have been unable to discover a single instance of this dreadful condition in which the Corynebacterium diphtheriae was indicted as the causal agent. Diphtheritic vulvo-vaginitis is a not uncommon clinical entity and numerous references to it are to be found in the literature.

It is therefore clear that a peculiar combination of circumstances, environmental and individual, not normally likely to arise, created conditions unusually favourable to an attack on a tissue not previously susceptible to the ravages of diphtheria—namely the scrotal skin. The epidemic was marked by no less than 167 instances of diphtheria of the scrotal integument. In 99 cases the scrotal disease occurred in the absence of clinical signs of involvement of the nose and/or throat; in 10 instances there was associated cutaneous diphtheritic ulceration elsewhere on the body; in 53 examples associated nasal, faucial or naso-faucial diphtheria was present; and in 5 cases labial diphtheria co-existed (Table IV).

<table>
<thead>
<tr>
<th>Month</th>
<th>Pure scrotal Cases</th>
<th>Deaths</th>
<th>Scrotal and labial Cases</th>
<th>Deaths</th>
<th>Scrotal and faucial Cases</th>
<th>Deaths</th>
<th>Totals Cases</th>
<th>Deaths</th>
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<tr>
<td>Aug.</td>
<td>19</td>
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<td>1</td>
<td>13</td>
<td>1</td>
<td>33</td>
<td>1</td>
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<td>Sept.</td>
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<td>4</td>
<td>6</td>
<td>25</td>
<td>5</td>
<td>88</td>
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<td>Oct.</td>
<td>22</td>
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<td>3</td>
<td>13</td>
<td>3</td>
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<td>—</td>
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<td>1</td>
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<td>Dec.</td>
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<td>Jan.</td>
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<td>2</td>
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</tr>
<tr>
<td>Totals</td>
<td>99</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>1</td>
<td>53</td>
<td>10</td>
<td>167</td>
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</tbody>
</table>

As has already been discussed explosive and extensive epidemics of cutaneous diphtherial lesions appear to depend on at least a number of associated circumstances. Extensive dissemination of virulent strains of the Corynebacterium diphtheriae linked with peculiarly vicious environmental conditions seemingly constitutes the necessary setting, but the actual precipitation of an epidemic evidently depends on the existence of suitable predisposing skin lesions. In other recorded epidemics strict specificity of such predisposing skin lesions has not been an outstanding feature but in scrotal diphtheria the preliminary breach of epidermal continuity was of unvarying constancy in its origin.

The way to infection of the scrotal skin in every case lay through the open door provided by the condition of scrotal dematitis. Without doubt this cutaneous disorder explains the great numbers of a remarkable and distressing diphtherial localization. The syndrome represented by angular stomatitis, glossitis, and scrotal dermatitis is generally accepted at the present time as a
manifestation of $B_2$ complex deficiency and more particularly of riboflavin insufficiency. The hyporiboflavinosis triad was extremely common amongst the prisoners during July, August, September and October 1942 (Burgess, 1946). Indeed, in my own experience quite a small proportion of the prisoners failed to present the stigmata of the triad in some degree if carefully sought during this period. During these same months the outbreak of scrotal diphtheria ran its main course. I have no shadow of doubt that the great numbers of scrotal infections amongst the prisoners can, in the final reckoning, be traced to deficiency of riboflavin in the diet.

The scrotal part of the syndrome was represented in the first instance by an erythematous, extremely itchy and irritable, dry, scaly and rugose condition of the scrotal skin. There followed, especially if chafing aggravated affairs, a very red, superficial, eczematous dermatitis which finally deteriorated to a moist weeping state with profuse sticky discharge. It was at this point that infection with the Corynebacterium diphtheriae appeared to occur.

The advent of the diphtheritic infection almost invariably ushered itself in with a notable increase in pain and discomfort. Accurate assessment of the incubation period proved difficult but no definite indication that it might differ materially from the well-established figures for faucal cases was forthcoming. An explanation of the increased pain was not long wanting, for within a few hours the scrotal skin and subcutaneous tissue were seen to be the seat of an acute, rapidly spreading inflammatory process. The most noteworthy feature of this inflammation was an extraordinary thickening of the scrotal integument due to widespread infiltration with inflammatory oedema fluid. In consequence, the scrotum presented a rather curious appearance and texture somewhat like an exceedingly thick, rubbery, partially distended balloon. The scrotal contents appeared to escape entirely and no effusion into the tunica vaginalis was detected. Oedema of the prepuce was an associated phenomenon in many cases but otherwise the swelling was confined to the scrotum.

Coincident with this inflammatory oedema, in the pure scrotal case where no other focus of diphtheria existed, the whole eczematous area of scrotal skin became covered with a thin, dry, brownish, adherent crust, within which crusted area a number of centres of more or less deep ulceration rapidly developed. These areas of ulceration were almost diagnostic, being in the majority of cases multiple, rarely greater than half an inch in diameter, punched out and quite deep. The ulcer floor was a very typical yellowish white or grey, soft, rather exudative but firmly adherent membrane highly reminiscent of the faucial lesion. The ulcerated areas assumed all sorts of shapes but for some curious reason were frequently roughly triangular. Unusually the ulcers were larger, even attaining the size of a half-crown and quite exceptionally there was a single large ulcer. An atypical form seen in some half a dozen cases was a much more extensive but more superficial ulceration with beautiful serpiginous edge, covering half or more of the scrotum and lined throughout with the grey membrane.

Reaching their half-inch or occasionally greater size, the ulcers tended to
Enter a limiting phase becoming more indolent with little tendency to extend and coalesce. A most disturbing feature, however, seen in about one-fifth of the cases, was the liability of the infection to creep outward and backward to reach the inner aspects of the thighs, the groins and the perineum. The occurrence of this unfortunate sequence was prone to end in ulceration of disturbingly deep order and in two cases we had several days of anxiety for the femoral artery. The penis too was liable, because of its position, to become involved in the process and a small focus of ulceration frequently developed on the prepuce.

A considerable degree of inguinal adenitis and peri-adenitis was to be expected but never to the remarkable extent of the typical “bull neck” of some faucial cases. The final picture was therefore one of a thick, balloon-like scrotum covered with a thin brownish crust, with perhaps half a dozen quite deep triangular ulcers lined with grey membrane. One of these ulcers located near the junction of scrotum and thigh might be tending to spread outwards to slough quite deeply in the superficial tissues of the thigh.

The unfolding of this sequence of events occupied a period varying from five to fourteen days but, remarkable though it may seem, failure to achieve control of the local lesion ultimately did not arise in one single case provided there was no coincidental faucial or naso-faucial infection. However, in 5 cases, control was achieved only after the resort to our minute and precious stocks of antitoxin. In the absence of serum but with complete rest, marmite and suitable local dressings, the spread of infection and ulceration was ceasing as a rule about the sixth to tenth day. By the fourteenth day, the membrane and sloughs were separating and soon a clean healing area was left, the final process or restoration being achieved in some five to six weeks. It should be remembered that these patients were as a rule much debilitated and healing wounds of all types was liable to be a somewhat laborious and protracted affair.

The scars left were quite strong, smooth and depressed. Some of them will undoubtedly suggest healed syphilis if seen by physicians in this country. Since no vital structures were implicated and since these scars showed no tendency to break down, the end-results can only be described as most gratifying. Areas of scrotal skin not involved in the ulcerative process returned to a normal healthy appearance.

In view of the extensive nature of these lesions it will hardly come as a surprise when I say that general constitutional features were far from insignificant. The condition when fully developed was associated with extreme discomfort, but not much actual pain. Fever of the order 99-100° F. was usual and the pulse frequent (circa 100). The more severe case presented the picture of a very sick patient with toxemia and prostration prominent. It may be mentioned that the toxæmia of the great majority of the scrotal cases was in marked contrast to the good general condition of other types of pure extra-faucial diphtheritic infections, seen during the epidemic. An easing of the toxæmia and prostration was a feature anxiously awaited, for it meant that improvement in the local lesion was soon to follow. Such easing usually appeared...
after some five days but might be delayed for as long as ten days and in extreme cases even for two weeks.

A co-existing respiratory localization exerted a marked influence on the scrotal lesion. Anterior nasal rhinitis was an associated infection in 36 instances. In these cases the scrotal lesion while following the pattern of the pure scrotal cases described above was almost invariably of quite mild degree. Indeed so much so as to raise the possibility that the patients in this category possessed at least some degree of immunity.

The story of coincident scrotal and faucial diphtheria presented a very different picture. A case fatality-rate of almost 60 per cent (if a percentage may be permitted in a small series of 17 cases) is sufficiently startling in any infectious disease. In diphtheria it is almost horrifying. The lethal propensities of this combination of localizations were remarkable, being surpassed only by laryngeal diphtheria.

The cases in this group fell sharply into two categories. In the first, numbering 6 examples, the scrotal lesion although varying from slight to severe conformed to the various gradations seen in pure scrotal diphtheria. All 6 made good recoveries, half of the group receiving antitoxin. The second group of cases, numbering 11 instances, presented a remarkable picture. Commencing as an ordinary scrotal diphtheria there evolved with dramatic speed and suddenness an extraordinary scrotal, perineal, and abdominal gangrene which spread in a totally uncontrolled fashion over the perineum, the inner aspects of the thighs and forwards, often widely, over the anterior abdominal wall. Extensive gangrene and slough with wide and deep ulceration especially in the crutch and much loss of tissue culminating in a green, grey, black stinking mass. Pari passu the throat infection extended widely upwards to the nasopharynx and downwards towards the larynx which it reached in one case. Toxæmia was overwhelming. The only case to survive was one receiving 30,000 units of antitoxin early in the disease which at least indicates that the condition might prove amenable to specific therapy. Although a good deal of tissue had been lost in this case and the contents of the scrotum exposed, tissue regeneration was remarkable and the end-result was eminently satisfactory. Amongst the 10 fatal cases the average period of survival was nine days the shortest being two days and the longest twenty-three days.

**Cutaneous Diphtheritic Ulceration**

In this country, chronicity, indolence, and resistence to treatment appear chiefly to have characterized cutaneous diphtheritic lesions and prompted the necessary bacteriological investigation (Rolleston 1928). Those features aside, a striking and readily recognized picture has been uncommon and the most usual story has been of an impetigenous-eczematous lesion, highly resistant to accepted lines of treatment (Dawson, 1910; Williams, 1943). Nevertheless it must not be forgotten that membrane formation is, on rare occasions to be found.

By contrast, those with experience abroad are generally agreed that the
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veldt or desert sore tends to run a special clinical course. “Beginning with a vesicle, usually round a hair follicle and at the site of some previous injury, this bursts and forms a shallow ulcer which is acutely painful. A chronic punched-out ulcer with undermined edges results and may persist over a long time” (Manson-Bahr, 1946). The chronic lesion is the subject of an excellent descriptive portrait by Cameron and Muir (1942). “The chronic sore was usually circular or oval, occasionally linear in an infected scratch, punched out and clear cut, varied in width from $\frac{1}{2}$ to as much as 2 inches. The edges were hard, raised and rolled, with a pale bluish tinge and the base was flat and even. In many it was covered with a leather-like, dark, scab membrane beneath which was unhealthy pus containing anaemic granulation tissue.

Perhaps the most striking departure from this classical picture under the climatic conditions of high humidity as well as high temperatures prevailing in Malaya was the apparent absence of the acute vesicle stage described by Manson-Bahr (1946). That this commencement never occurred I cannot certainly affirm for I did not observe many lesions from their earliest beginnings, but both my own conclusions and the conclusions of the many medical officers whom I questioned were against such a mode of onset. In addition, no patient ever described such a picture. The inevitable story was of a pre-existing lesion of one sort or another which underwent a rapid and serious deterioration or which entered a peculiarly resistant phase.

Unlike the scrotal cases, the predisposing lesion in this group was in no way specific—any skin lesion might suffice, but common ones were abrasions, cuts, bites, stings, scabies (a potent source), ulcerative dermatitis, burns, boils, epidermophyton and the breakdown of old scars. The series also includes three cases of true wound diphtheria—two circumcisions and a hernia wound. On the part played by less specific predisposing elements, I am unable to speak with any force. A diet grossly deficient in protein, vitamin deficiency, the possibility of a co-existing nasal or faecal carrier state and so on, all suggested possible lines of investigation which had however to be abandoned under the circumstances.

Cutaneous diphtheritic ulcerations were observed in 198 patients comprising: 186 instances of pure cutaneous diphtheria unassociated with clinical evidence of involvement of the nose and/or throat; 10 instances in which the specific ulceration co-existed with a respiratory localization (3 anterior nasal and 7 faucial); and 2 cases with concomitant labial diphtheria.

It may be, I think, worthwhile to consider here the first case of cutaneous diphtheria to be recognized in its acute phase during the epidemic, especially as a similar story occurred in the experience of Kay and Livingood (1946) whose attention was first attracted by a fatal cardiac case. I did not have the opportunity to examine this case and I am chiefly indebted to the notes of Captain E. K. Cruickshank, R.A.M.C., for the details of the case.

The patient was admitted early in August 1942 with a diagnosis of “severe ulcers of feet.” A few days later (approximately the eleventh day of the disease), a very slow pulse attracted attention and the findings at this point
were: pulse 32, B.P. 85/50, no enlargement of the heart or liver, sounds faint but pure. Three days later the patient's condition was unchanged save that the pulse was now 44 per minute. After the lapse of a further six days (twentieth day of the disease) the patient vomited several times, pulse 50 and very feeble, B.P. 78/50, and the heart sounds tic-tac. Suspicion that these changes were diphtherial in origin was aroused and smears taken at Captain Cruickshank's instigation were reported K.L.B. ++ but the patient's condition rapidly deteriorated over the next few hours and death supervened that evening. Autopsy (Captain Lennox, R.A.M.C.) revealed extensive and deep necrotic ulceration of the feet, a dilated and soft heart and numerous haemorrhages. Smears from the feet showed K.L.B. +++ and the picture was considered consistent with death from diphtheritic myocarditis.

Any attempt to produce a standard description of the clinical appearances of cutaneous diphtheritic lesions is, I feel, not only very difficult but rather unfortunate, for these lesions are prone to be distinctly protean in their manifestations and a preconceived picture was (and is) the surest route to a missed diagnosis. Nevertheless it is clearly impossible even if it were desirable to describe the 186 individual cases of pure cutaneous diphtheritic ulceration and in my search for some sort of categorization of the cases I found them to fall with considerable precision into two major classifications and each of these in turn are considered under the headings:

(1). Nondescript Lesions.
   (a) Bizarre Forms—28 cases.
   (b) Purulent Ulcers—33 cases.

(2). Membranous Ulcers.
   (a) With Grey Membrane—61 cases.
   (b) With Black Membrane—64 cases.

(1). Nondescript Lesions: This major group comprised 61 examples. Although without exception, they gave a positive growth of the Corynebacterium diphtheriae, the lesions possessed no outstanding clinical characteristics save chronicity, indolence, and resistance to treatment, which might strongly support the diagnosis nor were complications of such frequency or severity as wholly to refute the supposition that avirulent forms of diphtheroids were the organisms isolated. Nevertheless, at the time, I had no alternative but to regard the cases as instances of true cutaneous diphtheria and to base their management on that assumption.

   (a) Bizarre Lesions: Taking the form of persistent sinuses, paronychiae, infections of the nail bed, weeping epidermophytosis, anal excoriations, etc., these cases numbered 28. In the absence of suspicious associated circumstances there was nothing save chronicity and resistance to treatment to prompt search for the specific bacillus, but the presence of large numbers of cases of cutaneous diphtheria naturally led to the swabbing of any lesion which failed to respond to routine treatment. Great patience and insistence on complete rest are vital in treatment. All the cases were ultimately brought to a satisfactory conclusion without serum and complications were exceptional.
(b) Purulent Ulcers: This variety of sore, of which 33 examples were observed, at least gave rise to suspicion more readily than the preceding series, for the picture was a fairly characteristic one. The ulcer, or, as was more usually the case, the ulcers were as a rule around $\frac{1}{2}$ inch in diameter and rarely attained 1 inch in size. Comparatively shallow with an appreciably raised, indurated, rolled edge and slight surrounding erythema, the base on first inspection consisted simply of a copious pool of purulent fluid. If, however, the sore was cleaned up it could be seen to be lined with a thin, rather firmly adherent coating of grey membrane with a tendency to climb up the margins of the ulcer. Especially if not carefully examined, the lesion is not readily diagnosed by the uninitiated, but in time I became able to make a tentative clinical diagnosis with a good deal of confidence that the specific bacillus would be found, as it was in every case in the series.

The chronicity of these lesions was quite remarkable and their cure proved a severe drain on the patience of the unfortunate sufferers. Nevertheless a successful outcome was forthcoming in every case even without antitoxin.

(2). Membranous Ulcers: Into this major category no less than 125 cases could be considered to fall. As a series they presented a clinical picture so suggestive as to bring the correct diagnosis immediately to mind. To appreciate the appearance of these lesions it should be borne in mind that the exudative element of the diphtheritic membrane was somewhat in abeyance in this type of ulcer and that the element of coagulation necrosis, gaining the ascendancy, an extremely firm, tough, leathery slough rather than a membrane resulted. This scab-like structure was firmly adherent over its whole extent, removal being quite impossible (and ill-advised) without extreme pain until the natural process of healing had set in.

The peculiar factor of faucial diphtheria has a quality which has long defied description. Similarly the peculiarly foul and revolting odour emanating from a considerable proportion of ulcers in the membranous group, although to me quite characteristic, cannot be adequately described.

I would here emphasize that this cutaneous ulceration proved quite a different proposition from the lesions described earlier as scrotal and perineal gangrene seen in co-existing scrotal and faucial diphtheria. Cutaneous diphtheritic ulceration as I saw it tended almost invariably to enter a self-limiting phase spontaneously, whereas the gangrenous lesion possessed particularly uncontrollable propensities.

(a) The Cases with Grey Membrane: 61 cases presenting the picture of one, or more frequently from two to six ulcers oval or irregular in shape and some $1\frac{1}{2}$ inches by 1 inch, occasionally smaller but rarely much larger—the largest ulcer seen in this group being 2$\frac{1}{2}$ inches in diameter—provide the substance of this group. The appearance of the ulcers varied somewhat with size. The smaller ulcers were shallow and not uncommonly saucer shaped. The margin was sharp and demarcated by a slight rim of induration with surrounding moderate erythema and barely perceptible œdema but
little associated pain and tenderness. The larger ulcers on the other hand suggested a much more vicious infection, revealing an irregular step-like margin down to a depth of $\frac{1}{4}$--$\frac{1}{2}$ an inch, while in some situations, especially the groin, extremely deep penetration might occur. In this situation too there was a curious tendency to serious lateral extension with, as the end-result, a formidable serpigenous ulcer a couple of inches or more across. Only very rarely was the ulcer sharply punched out.

The typical, indeed the diagnostic feature was, however, the tough adherent, circumscribed, whitish, yellow, dirty grey or greenish slough occupying the whole floor of the ulcer. I never observed the membrane to extend beyond the margins of the ulcer.

(b) The Cases with Black Membrane: This type of sore formed by far the most striking picture and was observed in 64 cases. Single sores were common, although multiple lesions were still far from infrequent. Tending on the average to a considerably greater size, the dimensions varied from $\frac{1}{2}$ inch up to $4\frac{1}{2}$ inches, and all the very large ulcers conformed to this type. The shape of the lesion was subject to wide variation and a good deal of irregularity was the rule. A characteristic, especially of the larger ulcer was the abrupt, steep, punched out, sharp, cliff-like margin dropping to a depth even as great as $\frac{1}{2}$ inch. In the groin there was the usual tendency to burrow deeply and extend laterally often in a series of bay-like extensions. Rather greater induration, erythema and surrounding oedema especially with lesions about the feet was usual.

The membranous slough possessed its own special manifestations. The same dense, tough, thick, adherent structure; it was dark brown, hæmorrhagic or almost black in colour with a smooth dry scab-like surface. Separating almost en masse as a firm leathery slab with black upper surface and firm grey necrotic material below, it left a great trough-like ulcer with deep margins and a purulent base which when cleaned out revealed pale, coarse granulation tissue. With both types of membranous ulcer the regional lymph glands were implicated to a variable but never more than moderate extent.

Constitutional features in pure cutaneous diphtheritic ulceration were in the main conspicuous only by their absence, in contrast to the scrotal lesion. Toxemia was invariably absent in the nondescript type of lesion (bizarre and purulent ulcer forms). As a rule clinical evidence of toxemia was also absent even with quite large membranous ulcers although occasionally slight fever, tachycardia and a degree of prostration were noted. From time to time ulcer cases were admitted with a lesion three to four weeks old and a history of having "fainted" once or twice. Examination invariably revealed tachycardia, extra-systoles and the like indicating that myocarditis was already present.

The progress of the nondescript forms has already been detailed, the most prominent features being the extreme resistance to treatment of seemingly insignificant lesions. Progress in the membranous forms was also slow. In the absence of antitoxin the slough separated slowly—rarely in less than ten to fourteen days—to leave a dirty ulcer which, however, soon
cleaned up to yield a healthy granulating surface. From this point progress was again tedious. Epithelialization proved a difficult business and the end-results especially with the larger "grey" ulcer was a thin parchment-like scar very prone to breakdown under minor trauma. The final stages of healing were especially difficult. With the black membranous type progress was similar but epithelialization, despite the larger general size, easier and the scar, although still thin and parchment like, less prone to break down.

In three instances healing under conservative measures proved impossible. In one, the ulcer overlay a mass of scar tissue, a sequel to a shrapnel wound. It was ultimately considered necessary in these 3 cases to resort to excision of the scar and skin grafting with excellent results. In each case a small dose of antitoxin was administered prior to operation. I would emphasize my opinion that this represents the only place for active surgery in the treatment of these lesions.

Why the "grey" and "black" membrane forms in which the underlying pathology was clearly similar should differ in particulate detail—depth, size, ease of healing and so on was not clear but such differences were repeatedly observed.

The commonest site by far for these various ulcers was the lower extremity—feet, legs and thighs in that order; next came the arms; then the groins; the penis (scabies); the buttocks (scabies); the trunk; and finally occasionally the neck, the ears and the face.

**Complications**

It is proposed to deal here only very briefly with the very interesting problem of the cardiovascular and neurological complications observed in the extra-facial cases. Of the 167 cases exhibiting a scrotal localization, 12 ended fatally while non-fatal complications (circulatory and/or neurological) appeared in a further 37 cases. The case fatality rate was 7.18 per cent and the total incidence of complication 29.3 per cent. It is, however, of interest to deal with the different localizations of the infection as separate groups of cases.

On this basis the 99 pure scrotal cases suffered one death, a 19 per cent incidence of neuritis and a 12 per cent incidence of cardiac involvement. As neuritis and myocarditis were occasionally common to one case the actual number of cases exhibiting complications, fatal and non-fatal, was 26 in 99 (26 per cent). Of 17 cases with a co-existing scrotal and pharyngeal infection, 10 died and 1 developed non-fatal myocarditis. Concomitant anterior nasal and scrotal diphtheria was by contrast a relatively mild combination although non-fatal complications appeared in 8 of the 36 cases. One death and 3 cases with both myocarditis and neuritis marked the group of 10 patients with scrotal diphtheria and cutaneous diphtheritic ulceration elsewhere on the body.

In the cutaneous ulcer series the findings were very similar. Of the 186 cases exhibiting a cutaneous lesion only, one died from dysentery almost at the outset of the disease and may be excluded from the figures. The remaining 185 cases suffered 2 deaths, a 21.3 per cent, incidence of neuritis (40 cases)
and an 11.82 per cent incidence of cardiovascular involvement (22 cases). These complications were distributed over 52 or 28.1 per cent of the cases.

Of 7 cases with co-existing pharyngeal diphtheria and cutaneous diphtheritic ulceration; 2 died and 5 made uncomplicated recoveries. Of 3 anterior nasal-cutaneous cases complications appeared in one.

There were thus available for study 295 cases of pure cutaneous diphtheria comprising the 99 cases of pure scrotal diphtheria, the 186 instances of pure cutaneous ulceration, and the 10 examples with a combination of those two lesions. Clinical evidence of those cardiovascular and neurological complications which are peculiar to diphtheria appeared in 82 or 28 per cent of the cases. The case fatality rate from diphtheria was 1.35 per cent, the incidence of myocarditis 12.88 per cent (38 cases) and the incidence of neuritis 21.38 per cent of those exposed to risk.

**TREATMENT**

Under prisoner-of-war conditions the proper treatment of those cases presented grave and at times insuperable difficulties.

(a) Rest: The necessity for a proper nursing regime was self-evident and every effort was made to provide absolute rest as far as our circumstances permitted. A fairly satisfactory regime was achieved and in general consisted of three weeks flat in bed, four to five weeks slowly increasing activity in bed, four weeks activity in the ward and four weeks convalescent under supervision at the end of which period the patient reported back to me for final examination. This may appear unduly cautious but the lack of antitoxin raised problems in treatment to which our only answer was rest. Attempts to reduce these periods appeared to result in or, at all events, to aggravate paresis. Time being the one commodity which could be freely squandered it was early decided that the wisest policy was to make haste slowly.

In the event of evidence of myocarditis declaring itself an appropriate extension of those periods was made and a patient was always in bed until the heart had been normal for two weeks. When neuritis appeared after a patient had been allowed up he was kept in bed to observe progress as I was satisfied that continued activity was detrimental to such cases. However, neuritis having reached its height and begun to improve, the sooner activity within the limits of fatigue (in the absence of cardiac implication) was resumed the more satisfactory and speedy was the recovery of function.

(b) Local Treatment: The first essential of the local dressing in the scrotal cases was that it be continuously moist, both from the point of view of the comfort of the patient and in order to achieve control of the infection and healing. A multiplicity of solutions was tried such as eusol (½ strength), acriflavine 1/1000 in water, biniodide of mercury 1/4000 in water, normal saline, etc., but in the end a 5 per cent *boric solution* was found infinitely superior to all as it appeared to possess curious soothing and healing properties in the scrotal case. Dressings had to be well soaked and changed frequently as they became grossly soiled with discharge in a very short time. *Infinite pains* were required in applying the dressings so as to ensure non-apposition
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of all skin surfaces and to keep them that way. Only in this way could chafing and transfer of infection to the thighs, the penis and so on be minimized.

The general management of the ulcer cases was conducted on ordinary surgical principles. As a local application I favoured half-strength eusol or simply normal saline. I have already condemned active surgical intervention except to achieve healing in the final stages of difficult cases.

(c) Specific Therapy: (1) This therapeutic measure is included under “specific” for it was quite futile to attempt treatment in a scrotal case unless an attack was directed against the predisposing lesion. Pure vitamin preparations were not available and all manner of substitutes were tried including green vegetable extracts, rice polishings and so on but none were seemingly capable of producing the necessary concentration of the B complex and in every case resort to marmite or vegamite (fortunately available) became necessary. A suitable dose was 2 ounces daily but half this amount would just suffice in many cases. This preparation paved the way to recovery.

(2) Antitoxin Therapy: The administration of diphtheria antitoxin was an event especially in a pure cutaneous case for our supplies were very limited. Of the 365 cases only 25 received antitoxin. The dose varied from 8,000–30,000 units but was usually nearer the former figure. Even this may seem a heavy dose in view of the lack of the drug, but it must be borne in mind that our supplies had suffered many vicissitudes before reaching us. Much of it was long past the manufacturer’s expiry date and had spent months or years in a tropical climate without refrigeration. Whether for these reasons or because of the severity of the infections or because of the debilitated state of the patients smaller doses were prone to be ineffectual.

Amongst the 295 pure cutaneous cases with no associated respiratory localization only 13 received antitoxin. The group is thus for practical purposes non-serum treated. As a rule in these cases serum was given very late, eighth to twelfth day and response was slow but very satisfactory. Within five days a deteriorating lesion had invariably been converted into a healing one and there seemed little reason to doubt that with antitoxin available at an early stage little difficulty would have been encountered in these cases. Complications appeared in 5 of the 13 cases receiving antitoxin but of course the cases were all of the most serious type.

Summary

An account has been given of certain clinical data which it was possible to preserve relating to a group of 365 cases of cutaneous diphtherial infections amongst British Prisoners of War in the Far East.

The history of cutaneous diphtheria over the past century emphasizes the not inconsiderable importance of these infections to the Army hygienist in the field. Without being a problem of first magnitude amongst our armed forces, extra-faucial diphtheria has nevertheless been the cause of a great deal of protracted and incapacitating illness which might well have been prevented.
The epidemiological background is outlined, but the various and complex predisposing factors may be considered to amount in aggregate to a peculiarly vicious environment linked with a wide dissemination of the specific organism of diphtheria. The development of diphtheria on the unabraded skin is a subject of much controversy but Trousseau's dogma that diphtheria never "developed itself on the skin unless it was previously deprived of its epidermis or ulceration" applied fully in my experience.

The extra-faucial localization fell into two broad categories—scrotal diphtheria and cutaneous diphtheritic ulceration. Chiefly responsible for exciting my interest in extra-faucial infections, scrotal diphtheria was diagnosed in no less than 167 instances. In 99 cases no other focus of infection appeared to exist; in 10 cases there was associated cutaneous diphtheritic ulceration elsewhere on the body; and in 53 examples anterior nasal or pharyngeal diphtheria co-existed. 5 patients with labial and scrotal membrane complete the series.

The appearance of so great a number of cases of this curious localization could be traced directly to the widespread prevalence of the scrotal element of the hyporiboflavinosis triad of angular stomatitis, glossitis and scrotal dermatitis amongst the prisoners.

Diphtheria of the scrotum, in the absence of concomitant pharyngeal infection presented as a relatively acute, highly characteristic inflammatory lesion associated with an appreciable degree of generalized toxemia. Advancing rapidly to its peak over the first few days the inflammation soon entered an indolent phase persisting over the next two and even three weeks. With the cessation of activity the lesions healed slowly in men who were much debilitated and undernourished.

Positive cultures for the Corynebacterium diphtheriae were obtained in 125 cases while in 42 the diagnosis was clinical. Of these 42 no less than 20 later exhibited complications.

The cardiovascular and neurological complications peculiar to diphtheria were common following a scrotal localization, but chief interest probably attaches to the findings in the group of 99 pure scrotal cases. Over a quarter (26 per cent) of these patients developed myocarditis or multiple neuritis or both. Cardiovascular involvement was observed in 12 patients (12 per cent) and neuritis in 19 cases (19 per cent). Over the whole series of 167 scrotal cases the case fatality rate was 7.18 per cent, and the total incidence of complications peculiar to diphtheria 29.3 per cent.

Cutaneous diphtheritic ulcerations were encountered in 198 patients. In 186 no other focus of infection was discovered; in 10 instances there was a co-existing respiratory localization; and in 2 concomitant labial diphtheria. In 166 cases the specific infection was confirmed by the bacteriologist. In 32 the diagnosis was purely clinical.

The cutaneous lesions could be divided into two groups. The first of these, totalling one-third of the cases embodied nondescript or non-membranous lesions. The second group, amounting to two-thirds of the total
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was composed of lesions with definite extensive and characteristic membrane formation. The membrane presented as a firm, tough, adherent, leathery scab-like slough which might be grey or black in colour. The "grey" and the "black" forms occurred with almost equal frequency. Black membranous ulcers although tending to a considerably greater average size, healed more readily and were not attended by a significantly greater incidence of myocarditis and neuritis.

Myocarditis and neuritis were both frequent following pure cutaneous diphtheritic ulcers, the former appearing in 11.82 per cent (22 cases) and the latter in 21.3 per cent (40 cases). These complications were distributed over 52 (or 28.1 per cent) of the cases.

Of the 295 instances of pure cutaneous diphtheria in which no focus of diphtheria other than the skin or scrotum was apparent clinical evidence of those cardiovascular and neurological complications which are peculiar to diphtheria appeared in 82 or 28 per cent. The case fatality from diphtheria was 1.35 per cent, the incidence of myocarditis 12.88 per cent (38 cases) and the incidence of neuritis 21.38 per cent of those exposed to risk.

The measures of treatment adopted are outlined but the series is, for practical purposes, non-serum treated.

I am indebted to Lieut.-General N. Cantlie, C.B., Director-General Army Medical Services, and to The University of Aberdeen for permission to publish this report. I also wish to thank the many officers and men, too numerous to mention by name, who worked with me in the diphtheria wards. Their efforts above all kept the mortality from diphtheria within reasonable bounds.

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