ON SOME POINTS
REGARDING THE
DISTRIBUTION OF BACILLUS ANTHRACIS
IN THE HUMAN SKIN
IN
MALIGNANT PUSTULE.

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THE observations which I wish to bring under the notice of the Society are based upon the following case, the notes of which have been condensed as far as possible.

E. G—, æt. 29, by occupation a maker of knife-cleaning machines, was admitted into University College Hospital, on June 7th, 1884. The diagnosis of malignant pustule had been already made by the Resident Medical Officer, Dr. Maudsley, before I was sent for, and I had only to confirm the diagnosis on seeing the patient. The man, though of good physique, looked very ill; his expression was heavy and anxious, the skin of his head and neck looked dusky and greasy; his tongue was coated and his voice was thick. On the left side of the neck, lying upon

the sterno-mastoid muscle about an inch and a half below the ear, there was a large zone of vesicles surrounding a central eschar of dark brownish colour. The latter was hard, dry, and slightly depressed below the level of the belt of vesicles. These ranged in size up to that of a large split pea, and were filled with turbid yellowish or pink serum; they were very tense and hard. Beyond them the skin was much indurated, the whole sore measuring about 3×2 inches, the long axis of the oval lying across the neck. There was no great local heat, but much tenderness. Around this focus of disease the whole of the left side of the neck was much swollen, indurated, tense, and shining, the hardness reaching upwards beyond the ear and on to the cheek, downwards over the clavicle and across the middle line both in front and behind. The hardness was peculiar in its distinctness and unlikeness to ordinary cedema. There was considerable difficulty in swallowing and breathing, owing to the swelling having affected the inner surface of the pharynx. The patient's mind was quite clear and he had had no delirium; he seemed, however, worn out from want of sleep and food; there was a tendency to relaxation of the bowels.

He gave the following account of his illness:

On Wednesday, May 28th, 1884, he noticed a pimple on the left side of his neck, which was red and itched a little. On the following Saturday "a small black head" having developed he squeezed out the contents. At this time there was no particular swelling or redness around; but this was noticed two days later, and poultices were applied. On June 5th he became very feverish, and small vesicles appeared at the point of greatest swelling. These soon burst and discharged pale straw-coloured or pink serum. On the 6th, there was increase of difficulty in swallowing, this having been first noticed on the 2nd; the breathing had also become somewhat embarrassed. There were also marked restlessness, insomnia, and headache. Pain was not limited to the affected spot, but was felt all over the body and to a marked extent in the loins. There had

been anorexia and increasing weakness since the fifth day, and on the ninth day he had two rigors, followed by two more on each of the succeeding days.

He lived at St. John's Wood, but worked near the Tower. He had a good deal of handling of horsehair, bristles, and buff leather, but never raw hides. His own impression was that he had contracted the disease at a barber's where he had had his hair cut and had been shaved ; the barber also lived near the Tower.

There was no hesitation as to the treatment. Before operating, however, I carefully examined the serum of the vesicles and the blood for bacilli in the usual way, over and over again, but with a negative result. Still there could be little doubt as to the diagnosis. I therefore directed that a large piece of skin, including the whole area of vesiculation and half an inch beyond, should be excised in its whole thickness. The base of the resulting wound was mottled with dark patches, apparently plugged vessels. It was freely treated with the actual cautery and dressed with iodoform.

The morning after the operation the temperature was normal and the patient much better ; he made a rapid recovery from this time. Three days after the operation the blood and discharges were examined, but no bacilli were discovered. The patient left hospital on June 24th, with a small healthy wound still open.

Although the clinical history of true anthrax, both in animals and man, has now been written with completeness in this country by Mr. Davies-Colley,¹ and in Germany by Bollinger,² some points regarding its minuter pathology still appear to require further study in different cases. Among these may be mentioned, first, the general distribution of the bacilli anthracis in the affected skin round the point of inoculation in man, and next, their relation to the production of the vesicles and eschar so characteristic of

¹ 'Med.-Chir. Trans.,' vol. lxxv, 1882.

² Ziemssen, 'Handbuch der speciellen Pathologie,' Band iii (Translation, vol. iii).

the disease. In reading the literature of the subject, one is struck with the small amount of attention which these two points appear to have received in this country, indeed, with the exception of Dr. Charlewood Turner's admirable report of the microscopic appearances in Mr. Davies-Colley's case, I am not aware of any native source of information regarding them. The case now recorded offers such a good opportunity of studying the local disease that I have thought it not unworthy the notice of the Society. Generally speaking, it shows a close resemblance to the condition of things described by Dr. Turner. But there are some points regarding the distribution of the bacillus in which the two cases appear to differ, and there are others again a study of which in this case enables us perhaps to carry our observations a little further than Dr. Turner has done.

It is not improbable that the organisms may behave differently in and about the locality of inoculation, in different cases, or may vary in their habits at various stages of the disease. It is only by an accumulation of data bearing upon these questions that we shall be able to explain the very remarkable fact, now firmly established, namely, that free excision of the diseased area around the malignant pustule is followed, in a large proportion of cases, by rapid disappearance of all constitutional disturbance and by complete recovery. This was almost a startling feature in the present case. The disease had reached the eleventh day, the constitution was evidently profoundly affected, there had been several rigors, there were insomnia, anorexia, and great depression lasting for days, besides which the whole side of the neck was in a state of the most intense hardness, and yet after removal of the piece of skin, including the circle of vesicles, immediate disappearance of the constitutional and local symptoms resulted, and the patient was practically well next day.

This is a fact most difficult to explain. Many hypotheses may, of course, be advanced in an effort to clear it up ;

but it appears to me that, before everything, we need facts regarding the local habits of the bacilli anthracis in and about the malignant pustule, accumulated from the careful examination of a large number of cases occurring in the human subject. One very significant point is noticeable in this case, and is also alluded to by Dr. Turner, namely, that the bacilli appear to have a strong predilection for the most superficial parts of the skin, and for them only. If this rule should hereafter be shown to hold good in numerous other cases, it will strengthen the hypothesis that the organism can only attain to its fullest degree of virulence in the presence of light and air, and that though it may be carried to deeper parts of the body and perhaps increase there in a measure, nevertheless the original colony around the focus of inoculation on the surface may remain the principal, if not the only, generator of the actual poison, whatever it may be, which depresses the vital powers so powerfully. At present, however, I should prefer to pass by such hypotheses and to range myself with those who are endeavouring simply to accumulate such data as those to which I have just alluded.

The diseased skin immediately after excision was dropped into absolute alcohol and when hardened was frozen, cut, and stained in the usual way. The resulting microscopical sections were particularly satisfactory and from them I made the accompanying drawings (see Plate III) while the colours were vivid and sharply defined.

The first point noticed with the naked eye about the portion of skin excised was a peculiar dark mottling of its under surface corresponding to the area of the malignant pustule (fig. 1). This mottling appeared to be produced by either an intense congestion with some extravasation of blood, or, what seemed equally probable, a thrombosis of vessels with staining around them. The same appearance was noticed on the surface of the wound left by the excision of the skin. The next point noticeable was a distinct swelling of the diseased area, so that the corium was about twice as thick here as elsewhere.

This swelling diminished rapidly at the outer margin of the vesicles. The latter were of the flattened variety and covered an oval area around the central, dark, dry eschar (fig. 1). They were filled with pinkish serum for the most part. Their size was greater towards the advancing margin as if they had dwindled towards the dark, central area. The latter, on section, was drier and tougher than the rest of the skin.

On examination with the microscope, one is first struck with the great abundance of bacilli immediately under the vesicles and their fewness beneath the dry area of the eschar. In the larger vesicles they appear in smaller number than in the more minute, probably owing to their having been, for the most part, washed out in preparation of the sections. In some of the small commencing vesicles, on the other hand, they are packed as closely as possible and form a dark mass filling the space completely.

In the deeper layers of the rete mucosum and at the apices of the papillæ they are more abundant than anywhere else (fig. 2, *b*). Here they are seen by the hundred, packed so closely that under a low power they form a continuous, dark, waving streak following the outline of the papillæ. They are also seen to descend along the root sheaths of the hairs and are there in particularly large numbers (fig. 3, *c*). In contrast to all this, the bodies of the papillæ themselves show so very few bacilli as to suggest that any that are present have only been deposited there in the process of section cutting (fig. 2, *b*, *c*). Again, in the vessels of the papillæ I have not been able to find any organisms, though they have been carefully looked for.

The mode of formation of the younger vesicles is well seen in several of the sections, *e.g.* fig. 2. The irritation of the organisms in the deeper layers of the rete has caused an outpouring of serum among the cells underlying the epidermis, which has gradually forced the latter upwards forming loculi filled with fluid, between which delicate

columns of rete cells may be seen (fig. 2, *a, a*). Between these columns or bands of cells the bacilli are aggregated in dense masses in the smaller loculi, but in the larger they are found generally only around the borders, having apparently been washed out from the centre of the space in the process of preparation of the sections. Where no vesicles have yet formed, the apices of the papillæ are seen to swarm with bacilli and appear softened and somewhat broken up in consequence. Though the vessels of the papillæ and deeper parts of the cutis are well seen and contain blood-cells and *débris* I have nowhere been able to find organisms in them. Nor does the cuticle, or hair substance, appear to be in the least invaded by them.

From all this it would appear that the bacilli have a strong predilection for the most superficial parts of the true skin and remain for a long time limited to this region; also that they spread superficially along the tract of the soft cells of the rete mucosum. Again, it appears not improbable that when the vesicle bursts, the production of an ordinary suppurating sore is hostile to the life of the bacillus, possibly through the introduction and antagonism of other organisms. Numerous masses of what I take to be micrococci are to be seen in the borders of the area corresponding to the eschar.

These facts, pointing, as it would appear, to the at first purely local distribution of the organisms, help to explain the now common experience of the favorable results of excision of the diseased area even many days after inoculation.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' New Series, vol. ii, p. 17.)

DESCRIPTION OF PLATE III.

(On some points regarding the Distribution of *Bacillus Anthracis* in the Human Skin in Malignant Pustule, by ARTHUR E. BARKER, F.R.C.S.)

Fig. 1.—Diagram, natural size, of transverse vertical section through the malignant pustule, showing central, dry, thrombosed, dark area surrounded by vesicles, and outside these the healthy skin.

Fig. 2.—Vertical section of skin through the malignant pustule. *Hartnack*, obj. $4 \times 3 = \times 90$.

- a.* Horny layer of epidermis of collapsed vesicle.
- b b b.* Papillæ of cutis covered at their apices and sides by swarms of bacilli.
- c c.* Inflamed cutis infiltrated with leucocytes but showing few bacilli.

On the surface of the papillæ the rete is seen in the process of developing small vesicles, some of which have just become confluent.

Fig. 3.—Vertical section of skin. *Hartnack*, obj. $7 \times 3 = \times 330$.

- a.* Horny layer of epidermis.
- b.* Deeper layers, with vesicles commencing to form.
- c.* Root-sheath of hair with bacilli descending along its boundaries.
- d.* A large vesicle formed by raised cuticle.
- e.* Clusters of bacilli located chiefly on the surfaces of the papillæ and deeper layers of the rete mucosum.
- f.* Clusters of bacilli in individual cells.

Fig. 3.

Fig. 2.

Fig. 1.