

## The clinical aspects of anthrax

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### Summary

Cutaneous anthrax is usually easy to diagnose provided the doctor thinks of anthrax. The lesion most likely to be confused with anthrax is accidental vaccinia. Orf lacks the characteristic central eschar. Cutaneous anthrax responds to antibiotic therapy: rare complications are meningitis and hypoxic hypertension. Pulmonary anthrax is highly fatal: its incidence is related to the number and size of anthrax-containing particles which are inhaled. Artificial mists containing lethal doses of anthrax bacilli can be manufactured. Intestinal anthrax may present as gastroenteritis or as ulceration of the intestine with obstruction and perforation.

IN the 9th chapter of Exodus the Lord instructed Moses to demand from Pharaoh the release of the Israelites on pain of a grievous murrain to descend exclusively on the cattle of Egypt. Pharaoh was unmoved and his cattle died. The Lord again instructed Moses and Aaron to take a handful of ashes and sprinkle it towards heaven in the sight of Pharaoh. There occurred a boil breaking forth with plagues upon man and beast throughout all the land of Egypt. There can be little doubt that this is one of the earliest accounts of an outbreak of anthrax, and the handful of ashes must have been transformed into an aerosol of bacilli. Virgil described the illness no less vividly in the third book of the Georgics, where all the symptoms and signs of the disease as it attacks beasts in the fields or in the stalls are set forth, often with surprisingly modern epidemiological detail.

### Case report

A man whose job was to read gas meters borrowed a scarf from his son who worked in a tannery. This chafed his neck and rubbed some anthrax bacilli into his skin. A primary sore developed on the back of his neck (Fig. 1) with one violent, bullous haemorrhagic reaction sometimes seen in the worst cases (Freedman & Thorpe, 1969). He showed non-pitting oedema from his neck to his scrotum (Fig. 2) It healed with a black eschar which was very slow to separate (Fig. 3).



FIG. 1. Anthrax of neck with secondary lesions on chest.

The diagnosis of cutaneous anthrax is simple, provided the first doctor to see the case thinks of the possibility. The Report of the Committee of Inquiry into Anthrax (1959) says 'The problem is to raise the suspicion in the mind of the first doctor who has to deal with the patient and thereafter everything follows'. The Report comments that 'Other medical evidence suggests that diagnosis may not always be so easy'. The Report emphasizes the desirability of a worker in exposed employment having an anthrax card with pictures of anthrax lesions which he can show to the doctor when he attends with a sore on his skin. The doctor can hardly fail then to think of anthrax and carry out a simple test or refer the patient for another opinion. This has been the practice in Liverpool for many years and many patients have been seen at Fazakerley Hospital with boils and other simple lesions referred because of the nature of their employment. There is usually very little difficulty in making the diagnosis. A Gram-stained slide of serum from the lesion usually shows



FIG. 2. Same patient: oedema spreading to scrotum.

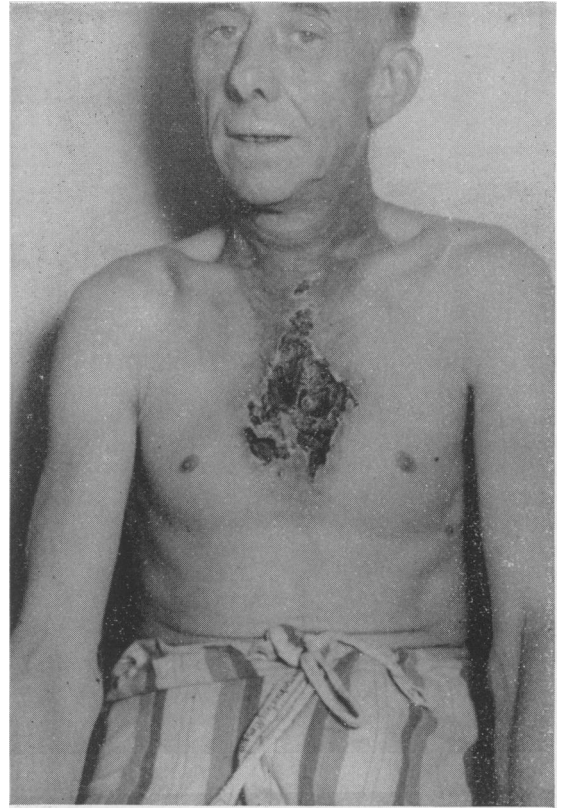


FIG. 3. Same patient: healing scab.

the bacilli if the case is anthrax. If pus is present it almost certainly is not anthrax. If there is doubt the patient can be admitted under observation till the result of culture is known the next morning. Guinea-pig and mouse inoculation is usually carried out by the bacteriologist, but the clinical appearance of the lesion, if it is anthrax, will usually have become unmistakable before the results of animal inoculation are known.

Difficulty arises when there is no obvious occupational hazard. Workers in factories handling bones ought to be made aware of the risk, but this is sometimes overlooked, and the only fatal case in Fazakerley Hospital was a young man employed in a glue factory who had been handling sun-dried bones. (Sun-dried bones are bones of animals that have fallen dead in the open: they are left to dry in the sun. They are preferred commercially to bones from abattoir-killed animals.) Workers who handle and repair sacks are also at risk, especially if the sacks have contained sun-dried bones or bone-meal fertilizer. There have, of course, been quite a few cases of cutaneous anthrax in this country in people who have used bone-meal on their gardens.

One man got anthrax after pruning roses, and at least one daily newspaper wanted to write a story on how anthrax bacilli could rise from the ground in the sap of a rose, but it turned out that the man kept his secateurs on a shelf in his garden shed next to a bag of contaminated bone-meal. Another patient was a grave-digger, an occupation which might well bring him into contact with old bones; but he had a spare-time job of cleaning out railway vans and some of these were badly contaminated with bone-meal. Recently a lady developed anthrax of the neck after sprinkling bone-meal on her garden. It has been shown that anthrax spores have remained alive in dry earth in a laboratory for over 60 years (Wilson & Russell, 1964). This finding was applied to the lady's garden. She apparently depended for most of her income on buying old houses, doing them up and selling them at a profit, and as this dwelling could now not be sold for at least 70 years she brought a claim for substantial damages against the firm supplying the fertiliser. Her friends and relatives were vaccinated against anthrax and she was advised to have no visitors. However, *Bacillus anthracis* has little chance of survival in competition

with the myriads of saprophytes and other organisms that flourish in the temperature and dampness of an English country garden (Hastings, 1923; Graham-Smith, 1941; Minett, 1950; Davies, 1960).

The typical anthrax sore begins as a nondescript pimple, but within 24–36 hr, at least, there has usually developed a black central eschar and a ring of purplish vesicles around it (Figs. 4 and 5). The lesion most likely to cause confusion is vaccinia, especially accidental vaccinia on the face or other areas not likely to be selected for vaccination (Figs. 6 and 7). Orf is a skin disease found usually in slaughterers or shepherds who may be in contact with sheep suffering from *ecthyma contagiosum*: it is caused by a virus and the appearance is more ragged and angry-looking than the malignant pustule of anthrax (Fig. 8). Second attacks of cutaneous anthrax have been reported: this usually consists of a pimple only, which would not be diagnosed except at an anthrax diagnostic centre. The same is true of anthrax in workers vaccinated against the disease: one such case showed a minute sore on the finger of an electrician who had pricked his finger with a wire while working at the



FIG. 4. Malignant pustule with ring of vesicles.

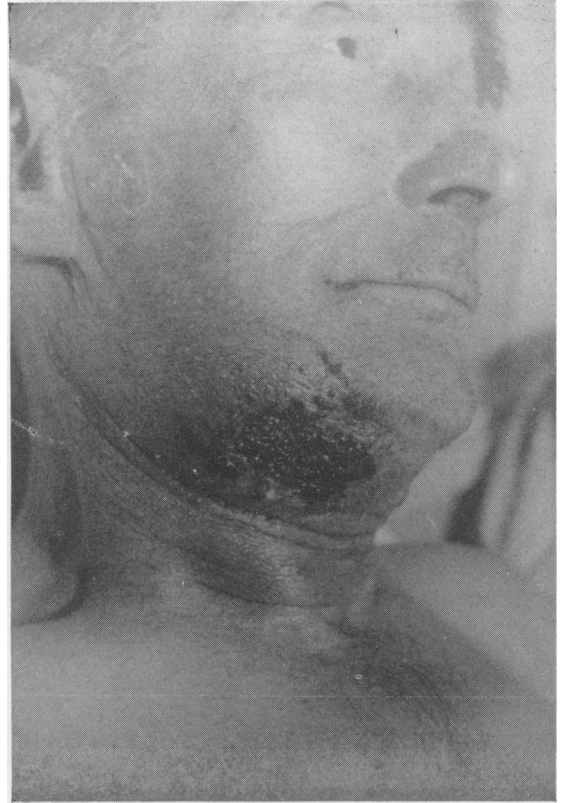


FIG. 5. Same patient: black eschar.

Government Disinfection Station at Liverpool. In another case a lorry driver who had been treated with long-acting penicillin for another condition contracted anthrax, probably from a load of bones he had been carting. He developed a highly modified sore on the forearm, not unlike, though larger than, the sore in the vaccinated patient (Figs. 9, 10 and 11).

Cutaneous anthrax has been, if not a mild, at least an easily manageable disease. It is not always so. Sudden unexpected death can occur (Report, 1959), the mechanism of which may be depression of cerebral cortical activity and of the respiratory centre, leading to hypoxic hypertension and cardiac collapse: this has been shown to occur in primates injected with either anthrax toxin or anthrax spores (Klein *et al.*, 1968; Vick *et al.*, 1968). It is certainly rare in man, though possibly common in animals. A commoner, though still rare complication, is anthrax meningitis (Drake & Blair, 1971). In an outbreak in South Africa involving eleven patients within one month five patients died, three of whom had meningitis. A fourth patient had anthrax peritonitis, probably due to perforation of an intestinal



FIG. 6. Accidental vaccinia.



FIG. 8. Orf.



FIG. 7. Accidental vaccinia.



FIG. 9. Modified anthrax.

anthrax ulcer. The fifth patient had septicaemia and pulmonary oedema; anthrax bacilli were cultured from the froth around the patient's mouth.

Pulmonary anthrax or woolsorters' disease is uncommon in Liverpool. This is a little surprising,

because in the working end of the Government Disinfecting Station at Liverpool, workers were always exposed to visible clouds of dust, and 33% of the samples of wool and hair were contaminated with anthrax. Visibility of the dust may, of course, give the clue, for few of these dust particles would be small enough to reach the alveoli. Brachman *et al.* (1960) calculated that workers in a goat-hair mill inhaled between 620 and 2200 anthrax-containing particles of dust during an 8-hr shift, but only between 140 and 690 of them were less than  $5 \mu\text{m}$  in



FIG. 10. Anthrax caused by carrying sacks which had contained bone-meal.

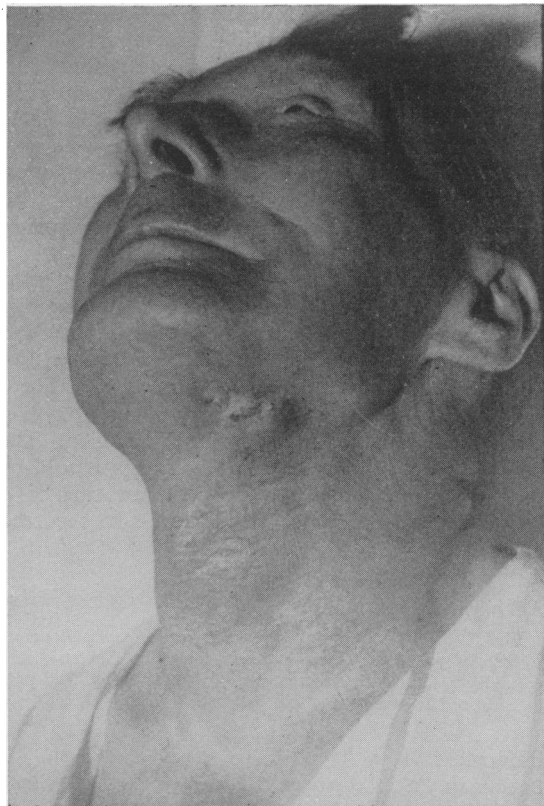


FIG. 11. Healed anthrax.

diameter and capable of reaching the alveoli. Nasal swabs of workers going off duty were commonly positive for anthrax bacilli. Even so, anthrax was uncommon in the mill, though in 1957 there was a sudden outbreak with four cutaneous cases and five pulmonary cases, four of which were fatal (Brachman *et al.*, 1960). Brachman and his colleagues have carried out several investigations on the effect of aerosols or naturally contaminated air when inhaled by monkeys. The incidence of fatal anthrax in the monkeys was related to the number of viable spores inhaled: when 17,000 were inhaled the death rate was 37.5%, when 1300 the death rate was only 7% (Brachman, Kaufmann & Daldorf, 1966; Daldorf, Kaufmann & Brachman, 1971).

This brings one back to Exodus and to the idea of bacteriological warfare. The organism and its spores can be produced in almost unlimited amounts in the laboratory and much experimental work has been done on the aerosol dispersion of the spores. Virulent antibiotic-resistant strains have been produced in the laboratory through selection procedures. Mac-

farlane Burnet & David White (1972) in the recent edition of their book in a chapter headed 'Perils and Possibilities' make this statement. 'It is physically possible to produce in a room a thin mist of bacteria so that any animal that takes a few breaths in that room will die, unless it is subsequently treated with an appropriate drug. To produce similar conditions over the large volume of air within and around an enemy city is physically possible, and in all probability the technical methods of achieving this have already been perfected. A ton of anthrax spores would contain about  $10^{18}$  individual spores. If these could be uniformly distributed in a volume of air 6 or 7 miles across and extending 300 feet upwards from the ground, each litre of air (about one deep breath) would contain about a 100,000 spores'. They do not suggest that such uniform distribution could be achieved, but they do suggest that 'the number of bacteria that could be carried in a single plane or in a single cluster of bombs might produce a startlingly large toll of illness and death'. The numbers are certainly far higher than those used in Brachman's

monkey experiments or counted in his goat-hair mill. The W.H.O. publication asserts that 'heavy concentrations of anthrax spores are feasible. This could result in up to 70-80% fatalities in untreated cases and in domestic livestock. Vaccines available at present might not avail against heavy aerosol exposure'. It also comments that decontamination of food and the environment and restocking with livestock would be difficult for a long period (Report, 1970).

Intestinal anthrax has been reported mainly from Africa, where it may cause gastroenteritis among natives who have eaten contaminated meat, but it can cause ulceration of the intestine with obstruction and perforation (Kohout, Sehat & Ashraf, 1964). There was an outbreak in South West Spain involving thirty-three patients, three of whom died. The infection was apparently traced to sausages sold by the village butcher. Intestinal anthrax can be a serious hazard on mink farms. It has also occurred among carnivores in zoos.

#### Acknowledgments

Figs. 1, 2, 7 and 8 are reproduced from *Infectious Diseases: Epidemiology and Clinical Practice*, by A.B. Christie, 2nd edn., 1973, Churchill Livingstone, Edinburgh (by kind permission of the author and publishers).

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