A DESCRIPTION

OF

A NEW PATHOGENIC MICROBE OF SEWAGE :
BACILLUS PYOGENES CLOACINUS.

By E. KLEIN, M.D., F.R.S.,

OCCURRENCE.

THIS microbe was isolated in pure culture from the purulent peritoneal and pleural exudations of a guinea-pig that died 48 hours after subcutaneous injection of a small amount of the deposit of fresh sewage; also from the subcutaneous abscess of this and the companion guinea-pig injected at the same time. The above purulent exudations, as also the pus of the abscess, were crowded with the microbe, either free in the fluid or enclosed in groups within the substance of the pus cells, some of the pus cells, packed with the bacilli, being swollen and disintegrating.

Morphology.—The microbe is a minute bacillus, the average length varying between 0.6μ and 1.25μ , few are longer, cylindrical, and in chains; its thickness is about 0.4μ . The thickness of the microbe in culture is a little larger than in the purulent matter. It is a non-motile bacillus; no movement can be seen in the hanging drop, although on staining for flagella, after van Ermengem's method, here and there a bacillus is found exhibiting at one end one short spiral filament. The microbe stains slightly in Gram (1 minute in gentian violet aniline water, 4 minutes in iodine iodide of potassium).

CULTURAL CHARACTERS.

In gelatine plates kept at 20° to 21° C. the first traces of growth show themselves after forty-eight hours in the form of grey translucent round dots; these enlarge slowly, forming circular flat discs, slightly thicker in the centre than at the margin. After a fortnight, that is, when fully developed, the colonies measure only $\frac{1}{2}$ to 1 mm. in width; they are grey translucent.

In gelatine streak the growth is grey translucent; when growth is complete, say, after two to three weeks, it shows under a magnifying glass a thicker knobby centre and a thin translucent margin, the breadth of the streak is not more than $1\frac{1}{2}$ to 2 mm.

In gelatine stab the track of the needle becomes marked as a thin whitish line, which under a magnifying glass is seen composed of closely-placed minute droplets; on the surface of the stab a circumscribed flat grey expansion is just noticeable with the unaided eye. The gelatine is not liquefied after weeks and months. On the agar surface the colonies are translucent grey, moist, viscid discs; in agar streak translucent grey viscid bands; in agar stab (37° C.) the growth is like that in gelatine stab, except that at the surface of the stab there is a circular distinct plate-like expansion of the growth.

In alkaline beef broth kept at 37° C. the growth is rapid; the broth is slightly turbid already after twenty-four hours, but after several days the broth clears and shows numerous fine granules along the sides and a powdery precipitate at the bottom of the tube. The broth, even after growth is completed, has a distinctly alkaline reaction; no indol is produced. The microbe grows well in litmus milk and in milk without altering either the litmus or the fluid condition, reaction, and aspect of the milk.

In shake culture in ordinary gelatine or in grape sugar gelatine it produces no gas; it grows very feebly in the depth of the gelatine. On potato no growth is visible or demonstrable by microscopic specimens. The microbe does not grow on acid media, and in fluid media distinctly produces alkali. Neither the pus of the abscess nor the purulent exudations nor any of the cultures have any smell.

ACTION ON ANIMALS.

The microbe, when injected in minute doses, is pathogenic. Small doses—even a portion of one colony—cause disease in the guinea-pig. When injected subcutaneously into the groin in the majority of instances only a local abscess is the result; this commences as a small tumour a day or two after the injection; this enlarges, and soon becomes changed in the

course of two or three days into an abscess, from the size of a bean to that of a hazel nut, filled with creamy thick pus. Under the microscope the fluid contains an abundance of the bacilli as single individuals, or more frequently as dumbbells, some few are cylindrical and some in chains. Many of the pus cells contain the bacilli, occasionally their protoplasm being packed with the bacilli. Some pus cells are greatly swollen by the number of bacilli, and eventually disintegrate, so that the groups and clumps of the bacilli become free. In a large minority of instances, however, the result of subcutaneous injection is, besides the local abscess, general disease, ending fatally in three to four days; purulent peritonitis, with pyogenic membranes covering the liver, spleen, and kidney; purulent pericarditis, the pericardial cavity being filled with grumous pus; purulent pleuritis, with pyogenic membranes and solid lymph in the mediastinum, the lungs deeply coloured and partially collapsed. Under the microscope the fluid is densely crowded with the bacilli, many pus cells contain in their protoplasm smaller or larger numbers of the bacilli, some completely filled with them, swollen, and in the process of disintegration.

When the result of inoculation is a local abscess only no bacilli can be found in the blood, but when it is a general purulent inflammation of the serous membranes, the blood of the heart and of the viscera, spleen particularly, contains an abundance of the microbe.

Injection of minute doses into the peritoneal cavity of guinea-pigs leads to fatal result within twenty to twenty-four hours. On *post-mortem* examination purulent peritonitis, with pyogenic membranes on the liver, spleen, diaphragm, and kidney, and inflammation of the small intestine, occasionally pleural and pericardial exudation are also present.

In the mouse subcutaneous injection of the culture in small doses causes general septicæmic infection, the blood of the heart and of the viscera teeming with the microbe, the viscera of the abdomen and thorax being greatly congested.

In the rabbit no pathogenic effect is produced either locally or generally.

From these observations, both as to cultural characters and as to the result of animal experiments, it is clear that our microbe is distinct from Passet's bacillus pyogenes fetidus, as also from Bolton's bacillus pyogenes soli. Culturally it resembles to a certain extent the bacillus suissepticus (German *Schweineseuche*) of Loeffler and Schütz, but the action of this latter on rodents is altogether of a different nature from that described above of our microbe. On account of its derivation from sewage and its conspicuous pyogenic action, I propose for it the name "bacillus pyogenes cloacinus."

REMARKS

ON

PLASTIC OR CROUPOUS BRONCHITIS.

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PLASTIC bronchitis is an affection which comes within the observation of few medical men. So rare is the illness that many physicians holding hospital appointments pass through their term of office without seeing a case. Within the last few months it has been my fortune to see two patients suffering from this uncommon malady. At *post-mortem* examinations of croupous pneumonia I have occasionally seen some of the bronchi occupied by firm fibrinous plugs, but in the patients whose notes are subjoined the illness is in no way associated with either pneumonia or tracheal croup. The cases are illustrations of plastic bronchitis, an illness whose pathology has yet to be written, since it falls to the lot of even the few fortunate physicians who meet with it seldom to see more than one or two cases. It is this circumstance that explains our rather scanty knowledge of the illness. From the photographs which accompany this paper an opinion can be readily formed as to the seat of formation of the casts. In neither patient was the larynx or trachea the least affected. Presumably therefore plastic bronchitis has nothing whatever to do with croupous laryngitis or diphtheria.

CASE I.—L. E., aged 47, a coal miner, was sent to me by Mr. Ingram-Johnson, of South Moor, on January 14th, 1899, suffering from recurrent

attacks of dyspnoea. Until three years ago the patient was a healthy man. At this time he had what seemed to be an ordinary but rather a severe cold on his chest. He had cough with expectoration and a certain amount of pain in his chest. The cough became paroxysmal, and was accompanied by an unpleasant choking sensation, which was always relieved by the patient expectorating a rounded mass of what seemed to be inspissated mucus. During these attacks pain was felt in the right chest, about the level of the seventh rib in front. These attacks continued off and on. As the patient kept ejecting the spherical masses already mentioned, he placed them in water, when they unrolled themselves into the dendritic forms exhibited in the photographs. In the course of an attack he might expectorate a few casts in rapid succession—say at intervals of five or six minutes—but on no occasion at this time could it be said that there was any trace of blood. Attacks of paroxysmal cough and dyspnoea with expulsion of casts have recurred at varying intervals during the last three years, and apparently without any definite relation to the season of the year or the nature of the weather. They have generally been preceded by symptoms of a "cold" and the expectoration of ordinary phlegm. His work has been interrupted from time to time by the attacks. For five months prior to Christmas he was quite well; he followed his occupation and imagined that he was cured; but the recurrence of an attack of even greater severity than before dispelled this belief.

On the whole his general health seems to be good. He is a well-built, healthy-looking man, and has never suffered from croup, diphtheria, nor syphilis. In his family history there is nothing of importance. His temperature is 98.4°, and it has never risen higher than this during the seven weeks he has been under observation. Pulse is 56 on an average; urine

Fig. 1.—From adult male.

is healthy; specific gravity 1035; no albumen, no sugar; heart is normal. Patient, who had expelled some casts on the morning of his admission, complained of pain over the front of the right chest, especially over the fifth, sixth, and seventh costal cartilages. He kept expectorating, with slight cough, large quantities of a clear gelatinous mucus containing very small portions of casts of the finer divisions of the bronchi. Immediately below the right nipple and slightly internal to it a small area of dulness is detected. The respiratory murmur here is neither so full nor so audible as elsewhere. The respiratory murmur over the front of the chest is at other places normal. Behind, at the level of the tenth right rib, about 2½ inches from the spine, is a small area over which a distinct cracked-pot sound is obtained on percussion and on auscultation small moist crepitant rales can be heard. The abdominal organs are healthy. Three days after this the cracked-pot sound was less discernible, and the crepitant rales had all but disappeared, and by the end of that week patient seemed quite well again. There was still cough, but it was no longer paroxysmal nor was it accompanied by dyspnoea.

Although at this particular time no fresh fibrinous casts were being expelled, he was still bringing up large quantities of a thin gelatinous gum-like liquid not unlike thin arrowroot made with hot water. The chest on both sides was now resonant from apex to base, with the exception of the slight area of dulness just below the right nipple, and over

which the breath sounds were still feeble. At the base of right lung posteriorly there could still be heard over a limited area on percussion a *bruit de pot fêlé*. The respiratory murmur, however, was healthy. Nine days after his admission patient brought up a few small casts rather shreddy, and on the eleventh day the expectoration contained the merest trace of blood. For several days the dulness at the right base remained, the cracked-pot sound disappeared, but the breath sounds here were harsher, and were occasionally accompanied by small moist rales. The progress of the case from this time was uneventful; his pulse at the end of his stay in hospital was 52, and his temperature varied from 97° to 98.5° F. Cough would occasionally be present, accompanied by expectoration of a gelatinous mucus free from the presence of pus corpuscles; this, although carefully searched, never contained any tubercle bacilli.

CASE II.—A boy aged 9 years. The notes of the case were kindly placed at my disposal by Dr. William L. Walker, of the Newcastle Dispensary. A pale, delicate child, the subject of recurrent paroxysms of cough and dyspnoea. A year ago he suffered from epistaxis, which would continue for eight hours at a time. Until five years ago, when he had rheumatic fever, he was healthy. Four months ago he began to cough up what he called "worms," for he noticed that sometimes if he spat into water the masses became unravelled, and assumed that appearance. In the case of this boy the expulsion of the bronchial casts is a matter of great difficulty. It requires hard and long-continued coughing to dislodge them. Frequently he has to sit up the greater part of the night in bed, coughing almost incessantly and struggling for breath. He only expels one cast at a time, and it has been noticed that the thick end is frequently tinged with blood. Very soon afterwards another cast is expelled. The patient can generally tell ten hours before the event, owing to an increasing sense of

Fig. 2.—From adult male.

suffocation, that he is going to expectorate a bronchial cast. Although considerably distressed in his breathing at the time, his mother has not observed him to be cyanosed. After the prolonged fit of coughing and straining the patient is thoroughly exhausted and falls asleep in a semi-upright position, bent forward, his forehead resting on his hands. His pulse is usually 120. Heart: apex beat is diffused; it is felt 2½ inches below and ½ inch external to left nipple. Here a loud blowing systolic murmur is heard, also over the right ventricle; the aortic sounds are normal. Lungs: Percussion note is resonant all over; crepitant rales are heard over both bases. Urine is free from albumen and sugar; it is deep amber-coloured, and contains urates. When the patient was examined two weeks subsequently there were dulness over the base of the right lung behind, and tubular breathing, with bronchial and crepitant rales, while over the left base posteriorly a few small bronchial rales were detectable. He had expectorated a few casts two days previously.

The points of interest in these two cases of croupous bronchitis are: (1) The absence of a history of any previous illness that could give rise to the formation of fibrinous casts in the bronchi; (2) the recurrence of attacks that are apparently not influenced either by weather or by the season of the year.

(3) sensation of an impending seizure; (4) paroxysmal character of the cough, accompanied by severe straining and a difficulty of breathing amounting almost to suffocation; (5) absence of pronounced physical signs of disease in the intervals; (6) absence of high temperature; and (7) in the case of the boy, coexisting heart disease.

As regards croupous bronchitis, neither sex is spared and no age apparently is exempted. According to Riegel,¹ plastic bronchitis occurs more frequently in males than females, mostly between the ages of 10 and 30, and it assumes a chronic rather than an acute form. There may or may not be any antecedent illness. There is an opinion that it only arises after repeated attacks of bronchitis, but in my adult patient there is no such history, and in the case of the boy there was pre-existing heart disease. In my older patient it would appear as if his first attack of bronchitis had almost at once assumed a croupous character, for the only immediately previous illness was what seemed to be an ordinary cold.

Plastic bronchitis is not, in my opinion, specially related to tuberculous disease. It is difficult to separate the two types of croupous bronchitis, acute and chronic, from each other. In the acute form the illness is said to commence with symptoms not unlike those of pneumonia. At first there is fever, followed by a dry hacking cough, pains in the side, dyspnoea, and a sense of oppression in the chest, expectoration scanty and becoming sanguinolent, occasionally hæmoptysis, and later on fibrinous casts are expelled with great relief to the patient.

Fig. 3.—From boy.

In the chronic variety there may be as in one of my own cases symptoms of an ordinary cold or of a mild form of bronchitis for a few days, but as time goes on instead of the symptoms improving the breathing becomes worse, the cough more frequent, and the dyspnoea greater, all of which almost immediately subside on the expulsion of the fibrinous casts. Although the plugs in my patients might show on their surface at the time of their ejection a trace of blood, or the expectoration become tinged a day or two afterwards, there was never anything like the hæmoptysis which some physicians have observed, and which suggested to them the possibility of plastic bronchitis being a tuberculous affection. Since it requires considerable effort and a good deal of straining to dislodge the casts, it would not be surprising if slight rupture of bronchial blood vessels occurred at the time. The process of expelling the cast is a laborious one; it brings the expiratory muscles fully into play sometimes for hours, during which there is a feeling of intense anxiety and a sense of suffocation. Each paroxysm may last the greater part of twenty-four hours. No wonder therefore after such prolonged expiratory effort and when expulsion has taken place the patient feels himself thoroughly exhausted.

When a fibrinous plug is forming in a bronchial tube, and apparently this takes place gradually, ingress and egress of air become correspondingly reduced. When the plug completely fills the tube, no air can enter. Over that particular part of the chest, therefore, no respiratory murmur will be

heard. It is this circumstance, along with a normal resonant note on percussion over a limited area of one lung that suggests the existence of croupous bronchitis, and if we are dealing with a patient who has on a former occasion had a similar attack, he is sure to have had experience of that feeling of suffocation already mentioned, and he will probably say that no relief is likely to be obtained until a plug is expectorated. The illnesses that plastic bronchitis might be mistaken for are the presence of a foreign body in the bronchus, pneumothorax, and tracheal croup. The history of the case would enable us to exclude the presence of a foreign body in the bronchus that had accidentally found its way thereto; a pneumothorax to be so limited would require to be encysted, and would probably present other physical signs of phthisis, and compared with tracheal croup there would be an absence of the "inspiratory dyspnoea" that is so characteristic of obstruction in the upper part of the respiratory passages. In the case of L. E. there was detected for several weeks after the expulsion of the casts a limited area of dullness over the base of the right lung, which may have been due to pulmonary collapse.

The pathology of plastic bronchitis is obscure. Why in the two patients whose notes form the subject of this paper limited lengths of the bronchial tree in one or both lungs should have assumed the habit under certain unrecognised circumstances of forming fibrinous plugs, I am not in a position to explain. Their formation seems to become a habit, and the only near approach to a similar state of things in what

Fig. 4.—From boy.

may appear to be healthy subjects, but with some local morbid peculiarity, is the shedding of uterine casts by women during menstruation. The cast that forms in membranous croup also resembles it, but I am not aware of children who have once suffered repeating the process time after time. It is to be presumed, therefore, that there is either a peculiar condition of the blood whereby the plasma which exudes on to the bronchial mucous membrane tends to assume the solid form seen in the cast, or there is some altered condition of the epithelial lining of the bronchi whereby a chemical and physical change is induced in the inflammatory exudation poured on to its surface. From the perfectly intact shape of the mould, the comparative absence of an epithelial covering and of accompanying blood when expelled, it would seem as if the epithelial lining was only very slightly involved in the process, and therefore the term "croupous" as applied to the cast is more correct than "diphtheritic." On microscopical examination the casts, which are greyish-white in colour, are found to be composed of layers of fibrin, in the meshes of which are very few corpuscular bodies. Here and there the lamellar layers of fibrin are separated by spaces which contain mucus and air. There is no indication of organisation. Ewart, in his article on Plastic Bronchitis,² quoting Waldenburg and Lucas-Championnière, mentions the occasional presence of fat in the casts, an observation confirmed by Model, who found the fat as a fine granular deposit or in droplets between the layers of fibrin. I have not observed this. Fibrin itself often

assumes this granular form. None of the casts brought up by my patients were hollow. They were semisolid, firm plugs, 2 to 3 inches in length, with beautiful arborescent endings. The centre of the cast would therefore be the first to have been formed, and subsequent increase in size would be due to fresh deposition. Hence their stratified structure. It is just possible that plastic bronchitis is not always of the same kind, and that, as in a case reported by Kretschy, there may be a pretty complete shedding of the bronchial epithelium. When this occurs there will be a greater tendency to oozing out of blood. How far, too, plastic bronchitis may be due to the action of microbes it is impossible to say. There must be numerous micro-organisms in the respiratory passages, and when present in the coagulated bronchial exudate it is impossible to say what part, if any, they may have played in its causation.

Griffon,³ in a communication to the French Anatomical Society, presented the false membranes and microscopical sections from two cases of croupous bronchitis, and gave the details of their bacteriological examination. His examinations rather suggest a different evolution for the two cases. In one the disease was acute. Streptococci were obtained from the culture. It was the only micro-organism present in the exudate. The other was a slower case and corresponded to the chronic type. The bronchial casts were highly developed, and exhibited numerous dendrites. Both sections and cultures were rich in pneumococci. Inoculations of a mouse with the cocci showed them to be very virulent. M. P. Claisse also isolated streptococci from an analogous case. It may be that the presence of these micro-organisms was simply accidental. Pneumococci are believed to live only a very short time in the lung; their presence, therefore, in the chronic case reported by Griffon would show that they were capable of living a relatively long time on the bronchial mucous membrane. No micro-organisms were found in the casts expectorated by my patients.

Treatment divides itself under two heads (1) means used to loosen and dislodge the plugs; (2) to prevent their recurrence. The employment of emetics seems rational, but unless the fibrinous casts are already lying loose, it is difficult to eject them by inducing vomiting. Besides, as we have no exact means of knowing when the plugs have become so thoroughly loosened that they can be thrown off, it is, on the whole, the wiser plan not to administer emetics. Various inhalations, medicated and otherwise, have been suggested, but in my experience I cannot say that any of them were of the slightest service. They were badly borne by my elder patient, a remark which applies equally to the use of the steam kettle. I regard the treatment of plastic bronchitis as, generally speaking, unsatisfactory. Nothing short of expulsion of the casts gives relief. Lime water or lactic acid sprays and inhalation, also solutions of the alkaline carbonates are not more reliable. The internal administration of iodide of potassium with or without expectorants gives as good results as anything. Ewart recommends the cautious intratracheal injection of oil, or a mild solvent such as lime water or trypsin. To prevent recurrence I know of nothing better than the employment of such means as will improve the general health, living in a dry bracing atmosphere, good food, the internal administration of tinct. quin. ammoniat., nux vomica, cascarrilla, with or without cod-liver oil.

The photographs of the bronchial casts were made by my clinical clerk, Mr. Robert Peart, who adopted the following method. The casts without any preparation were in a non-actinic light floated on paper under water and spread out with a brush. Both were then removed together, drained, exposed, and developed in the ordinary manner.

REFERENCES.

¹ Ziemssen's *Cycl. Pract. Med.*, vol. iv, p. 442. ² Allbutt, *System of Medicine*, vol. v., p. 30. ³ *Gaz. Hebdom. de Méd. et de Chir.*, March 30th, 1899, p. 303.

DEATHS IN THE PROFESSION ABROAD.—Among the members of the medical profession in foreign countries who have recently died are Dr. José Lacasa, Physician to the General Hospital, Inspector of Public Health, and a leading practitioner in Madrid; and Dr. Michael Rawitzki, of Berlin, recognised as an authority on old Jewish medicine, aged 59.

THE CROONIAN LECTURES ON SOME POINTS CONNECTED WITH SLEEP, SLEEPLESSNESS, AND HYPNOTICS.

Delivered before the Royal College of Physicians of London.

By JOHN BUCKLEY BRADBURY, M.D. CANTAB.,

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LECTURE III.

THE most important of the other derivatives of chloral is chloralose, first prepared by Heffter and introduced into therapeutics by Henriot and Richet. Like chloral hydrate it induces sleep, but instead of depressing reflex activity it markedly increases it, while its toxicity is greater. Why the combination of an inert sugar molecule with chloral should so greatly increase its toxic action and modify its effects is difficult to understand. It may be that the chloral molecule is presented to the tissues in a more readily assimilable condition. We know that chloral combines with glucose, and the product thus formed is oxidised in the system to urochloric acid, and this on hydrolysis yields glycuronic acid.

It is mainly to Richet and his pupils that we are indebted for our knowledge of the pharmacology of chloralose. They have chiefly worked with dogs. In these animals there is marked preliminary excitement followed by sleep. The muscles retain their tone, and there are increased reflexes especially to sound. Pain is said to be abolished. The respiratory movements become irregular, and finally cease, but the heart is scarcely affected, and the blood pressure is said to be raised above the normal. If artificial respiration be maintained, comparatively large doses have to be given before the heart is paralysed. Richet believes that the action of the drug is primarily upon the grey matter of the cerebrum, as he found after its administration the white matter was more sensitive to stimuli than the cortex, a condition the reverse of normal.

In man the drug is said to produce refreshing sleep without ill-effects. The blood pressure is raised, and the appetite stimulated. Muscular twitchings may occur, and in some cases even convulsions have been noticed; but Richet thinks the cases of so-called poisoning are misnamed, and that the recorded dangers are in reality advantages, as they show the activity of the medullary and spinal centres. As a result of giving chloralose, he says, the brain is asleep and the spinal cord awake or even excited.

The comparative toxicity of chloralose in dogs, cats, and birds per kg. body-weight when given by the mouth is as follows:

	Dogs.	Cats.	Birds.
Minimum active dose	Gram. 0.15	Gram. 0.005	Gram. 0.010
Hypnotic dose	0.25	0.020	0.015
Lethal dose	0.60	0.100	0.050

It will be noticed that cats are extremely sensitive to this drug, but they are also sensitive to chloral and chloroform.

My experiments have been made chiefly on rabbits, which are better adapted for comparative investigations than dogs or cats. The same symptoms are seen as in dogs, with the exception of the preliminary excitement—that is, cerebral depression follows in about half an hour; the animal, on attempting to move, rolls from side to side, and subsequently sleep occurs. But even then the reflexes are increased, the corneal reflex is distinct, and there may be nystagmus. Pain, however, is not abolished, as heavy pressure on the feet will produce marked reflexes where moderate pressure has no effect. The respiration is slowed, and to a less degree the heart beat also. The temperature falls from the first. A dose of 1 gram per kg. kills in two and a half hours. Similar effects are produced in guinea-pigs and rats.

Fig. 7 distinctly shows lowering of the blood pressure by chloralose. It was taken from a dog to which small doses of