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REPORT
UPON
MICRO-ORGANISMS IN SURGICAL
DISEASES.
Presented to the Scientific Grants Committee of the
British Medical Association.*

BY ALEXANDER ÖGSTON, M.D.,
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I.—INTRODUCTION.

The question, What is the cause of blood-poisoning? is at present the most interesting and important in pathology. Many answers to it have been attempted, and we are gradually coming to surmise what the true one will be. A coincidence between the presence of microscopic organisms and blood-poisoning is becoming more and more evident; but mere accumulation of such evidence can never be satisfactory. A single negation destroys them all; and negative observations have been wanting. Instead of multiplying examples of coincidence, the time has clearly come when we must go to the elements of the subject, and ask, What can these organisms be proved to do? Have they any connection with the simple as well as with the more complex forms of disease? And what difference does there lie in the effects of the different kinds of micro-organisms?

The present investigation was instituted to carry out this plan—to answer these questions. But the subject is large; and it was found necessary to limit it to one organism, namely, the micrococci. Ewart's investigations (Proceedings of the Royal Society, 1878) have shown that we must distinguish four forms of micro-organisms: 1. The spirillum, or corkscrew-shape; 2. The bacillus, or rod-shaped; 3. The bacillum, sausage-shaped, like a short bacillus; and 4. The micrococcus, with a spherical or faintly oval outline. The micrococcus has been held to be the most potent factor in producing blood-poisoning (Billroth, Israel, Kocher, etc.), and has also been asserted (Watson Cheyne) to be an inactive organism. The most recent investigations of the Committee of the Pathological Society (Transactions of the Pathological Society, vol. 3, 1880) have left this point still undecided.

In the present investigation, every means was taken to overcome the chief difficulty met with in such attempts; viz., how to recognize micrococci, and distinguish them from all other bodies with absolute certainty. Observation with high powers; the use of acids and alkalis to bring them out more distinctly; observations in fresh as well as in preserved tissues and fluids; cultivation of control experiments with every step; and utilizing the applications of the Japanese system, were all employed with the utmost minuteness and regularity. But the main reliance was placed on the methods recently introduced by Koch of Wollstein for the demonstration of micro-organisms. This observer has asserted (Archiv für Wundheilkunde ihrer Abhängigkeiten, 1878) that, by a suitable arrangement of light, it is possible to ascertain the existence of microorganisms in the tissues, even when they exist in an infinitesimal form. In observing tissues, the structures were, immediately on the death of the animal, placed for two hours in a solution of 15 per cent. of mercuric chloride, and then immersed in a fixative whose muriatic acid and alcohol were added, and finally ground up in a small quantity of alcohol, and finally mixed with an alcohol absolute solution of a 15 per cent. of mercuric chloride. After allowing the tissues to stand for some time, the resulting solution, containing a very little alcohol, was allowed to cool, and mounted in a drop of commercial Canada balsam. The liquids employed were carefully examined for micrococci, and found to contain nothing. A solution of 15 per cent. of mercuric chloride, showing Brownian movement; but after a short time they sank to rest; and are then seen to be amorphous granules of the pigment. Many of the micrococci were found more or less adherent to the methyl-aniline-violet; and even among the samples of the violet bent where they were the commerce of commerce to their. It stains the sections of an uniform deep violet but the colour becomes gradually fainter as they are washed through the other fluids until at last they pass merely a pale violet tint; and, under the microscope, show only the nuclei, the granules of the cell-protoplasm, and the micrococci deeply stained. A prolonged sojourn in the solution of methyl or acetic acid removes all colour; and only the micrococcus also retains it, though less rapidly, so that it is of some consequence as we are in preparing the sections. Slight variations from the above procedure make little difference to the results here, indeed, sometimes desirable, so as to leave the requisite depth of staining; and it is better to remove too little than too much of the dye. Canada balsam, prepared with turpentine or benzole, quickly extracts all colour; so do dammar mounting, glycerine-jaconite, etc., and the sections will not keep. Hence the balsam must be used pure.

In observing liquids, such as blood and urine, dissolve off the slide, if left for sixty seconds exposed to the water of the dye. Thus the film is to be treated as follows. A thin film of them is prepared as before. After it is formed over a spirit-lamp, a drop of aniline solution, of the strength of two grains to the fluidounce, is quickly applied to the slide by a thick glass rod or pipette; and it is instantly placed under a gentle stream of water, so that the dye is immediately washed off. The film thus treated does not dissolve, but remains on the slide, and is dried and mounted as before.

In sections so prepared, the micrococci are unmistakable. They are deep violet-purple in combination with the surroundings, and offer a marked contrast to them. With a good magnifying power of four hundred diameters, the organisms, especially those in liquids, are readily seen; those in the tissues of infected areas are great in care, and may not be visible even with a good sixteenth of an inch water-immersion. The surest way of demonstrating them is to employ the methods of Koch. These were used here as follows. The slides were examined by a microscope fitted with a one-eighth of an inch oil-immersion obtained from Zeiss of Jena; the tube of the microscope being 155 millimetres in length; and of the oculars employed being 2, 4, and 5 of Zeiss's manufacture. The staining condenser was that of Professor Abbé, without any diaphragm; the illumination was good gaslight, concentrated by a blue-tinted bull's-eyes condenser on the flat side of the mirror. It is quite possible to overlook the micrococci in the tissues, even with the brilliant light so afforded. I am satisfied I have sometimes overlooked them when the staining had been rather faint but usually a little care would cause them to be plainly visible as can be desired. One cause of difficulty is the apparently smaller size of the micrococci found in the tissues. This is probably due to the colour being diminished from the water-immersion required to be used, and left only in the centre. Professor Cosset Ewart, an eminent authority in this investigations, informed me that the bodies in question were what I had supposed them to be.

Wolff (Gesellschaft für Chimie, 1879, No. 51) has recently stated, as an objection to Koch's staining methods, that there exist in the blood and tissues numerous granules, which, when stained with aniline, are indistinguishable from micro-organisms. It is undeniable that such bodies exist, but they do not occasion the smallest difficulty. Microorganisms in disease do not exist in the form of scattered, isolated, hair-hazard bodies; they are growing, and that actively; and, as will be shown further on, they grow in such a definite recognisable form that their presence, not to mention their existence, is a matter of universal and it is impossible to confound them with any such granular bodies as those stated to be by Wolff. Indeed, micro-organisms, if found isolated in such a state to leave a very good idea as to what they are and what they are doing, are probably merely accidentally introduced, and it would be safe, even prudent, totally to disregard them.

It has been found impossible to give in this report a detailed protocol of individual experiments, etc., it will be seen, as the separate branches

* With lithographic illustrations.
† Throughout the present paper, the term blood-poisoning, though loose, is used as including pyemia, septicemia, and other infective processes.
II.-MICROCOCCI IN INFANTRY.

It is by no means easy to obtain any single form of organism pure from admixture of others. Micrococci are not readily purified, and even in the pus which flows from an acute abscess on its being opened. One observation, after another showed this to be the case; and as they accumulated, gave rise to a suspicion that this, was due to something more significant than a mere coincidence. Kocher of Bern ("Zur Kenntniss der akuten Bestandehgen der "Arch. f. Klin. Chir."") has, in a publication of the same name, published in 1876, drawn attention to the possibility of all acute inflammations being due to micro-organisms; and the confirmation given to his supposition, by the constant presence of micrococci in pus, led to the present investigation being in the first place directed towards the unseen agents of their existence there, and the connection which they have with it.

A series of abscesses were examined, eighty-two in number. Of these, thirteen were chronic typical "cold" abscesses, whose duration could be measured by weeks; and which had followed diseases more or less allied to, or complicated with, forms of blood-poisoning and bacte-
riemia; such as typhus, phthisis, scarlatina, erysipelas, typhoid fever, and tuberculosis.

All of these contained micrococci, and were evidently the same as the latter form.

Lastly, sixty-five were acute abscesses, whose duration could be measured by days, not by weeks, from all parts of the body. Everyone one of these contained micrococci.

All the abscesses had been litherotomised, and the pus was taken from them, by means of a needle or knife, while still flowing from the incision, spread out in a thin film upon the slide, immediately dried, and prepared as already mentioned. All abscesses that had been already opened, or that had spontaneously burst, were carefully excluded.

A large proportion of the abscesses came under my own personal observation, and the one of them the pus was obtained for me, and prepared according to printed directions by several medical men, among whom I have especially to thank Drs. Hall, Jackson, MacLeod, Osgood, Leis, Reith, Robertson, and Smith-Blanc, of Aberdeen; Mr. Dalgetty, of Aberdeen; and Drs. Cruickshank, Thomas, Keith of Abney, Lyon of Peterhead; Milne of Cluny; Robb of Portsoy; and Sheriff of Ballater.

The acute abscesses were:-

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It was impossible that micrococci in any numbers could have flowed into the pus in the two seconds required for transferring it to the slide, the fluids employed were not the source of these, and the inference seemed to be certain that micrococci had existed in the interior of the abscesses and pyogenic abscesses, and had been absent in all the "cold" abscesses. The forms in which the organs showed themselves corroborated this. They had been growing.

They were seen as chains (Fig. 2), of from three or four cocci, up to ten or much larger numbers. Generally five or six cocci were seen at any one time, and often ten to twenty were found; and in some specimens they existed as equivalent in their extent, to twenty or thirty whole cells, placed in a row. In one specimen, a chain consisting of thirty-five cocci was observed, and this by no means the largest one observed. The chain-shape seemed to be the only form present in certain of the visible it was seen to consist of chains interwoven with each other, and entangled into a mass (Fig. 2) wherever chains of any length existed. In the grouped form division took place in any direction, a single coccos seemingly dividing into two, three, or four cocci, and a continuance of this form of the groups. Many of the masses produced by pairs being first formed, each of which again formed pairs, and so on; but many were clearly, from the equal size and relative positions of the cocci, formed by a direct division. Although more rarely, into threes (Figs. 1 and 3). The groups formed by this mode of division had no appearance of being built up of chains.

The micrococcus present a capsule surrounding each ball, and binding them together into chains and groups. It appears as a glistering halo when they are unstained; but, after being stained and dried, it becomes invisible, and they present the appearance of being independent spheres. In some cases, however, in which it seemed that the cocci differed from the others by being unusually large, and consisting of showing transparent intervals between the cocci as in Fig. 5, the usual arrangement, had an amount of colour between them that depended either on their being piled up one behind another, or on the existence of a staminate interposed substance, giving them the aspect of groups.

In some cases, unusually large oval cocci (Fig. 6) existed, chiefly in pairs.

In the most part these varieties existed in separate abscesses, but it frequently occurred that an abscess contained both chains and groups. Out of sixty-four abscesses where this point was specially noted, seventeen contained chains only, thirty-one contained cocci only, and sixteen contained both forms or only pairs.

Sufficient evidence was not obtained to decide whether these different appearances indicated different species of micrococci; but the constancy with which chains produced only chains, and groups only groups, in the various experiments that fall to be detailed, indicated, rather favoured the suspicion of their being so. No difference could be noted in the characters of the abscesses that contained them.

Variations in the size of the cocci often existed in the same pus. Some were as large as 1.750th of a millimetre, or even more; some as small as 1.450th of a millimetre, or even less.

They possessed a natural tendency to conglomerate, and isolated cocci were agglutinated on oscillatory jerking motions on their own axis, with a slight tendency to be jerked out of the place they occupied; pairs showed a somewhat rhythmic movement round their bond of union, that could be best likened to the motions of a staminate; and the groups and chains were disturbed by similar slight movements which caused them to alter their position. The result was, that the cocci travelled. One chain of eleven cocci, for instance, when examined for twenty-five minutes, moved in that time three times its own length, working in its way through a countless mass of albumen. It moved slowly; and, the rate of progress seemed uniform, as it took eight and a half minutes to move its own length. No flags were discovered to explain the movements.

The numbers in which micrococci existed in pus varied greatly. It was possible to distinguish them from granules, so as to count them, either they were dried and stained. The hemacytometer was used to calculate the number of cocci. A limited number of specimens of pus mixed with blood were selected for this purpose, as many as fifty cocci were taken from pus from acute abdomens, and five of pus from cold abscesses. Of each sample, forty estimations were made by
The average was: therefore, 975,275 per cubic millimetre in the pus from acute, and 395,000 in pus from cold abscesses. According to these results, 500,000 was assumed to be the average number present in each cubic millimetre of pus from acute abscesses, and from relation to the corpuscles as it was easy to count the micrococci by finding out their number and size, it was then found that

1 contained about 45,000,000 micrococci per cubic millimetre.

giving an average of 2,900,025 micrococci in each cubic millimetre.

The observations were enormous: it will be observed, for example, contained only 900 per cubic millimetre. It seemed also to be the case

distributed throughout the pus. A drop taken from one part of the pus showed more; but from another part fewer; they seemed more than there were not uniformly distributed. Still, even where there were acute abscesses, when examined with care, to show abundant evidence

In this case both bacilli and bacilli, bacteria; and in some cases bacilli, bacteria, and spirilla were present, but the micrococci were the only constant organisms.

Micrococci in pus existed almost always in the same from the beginning of the disease, and also in bacteriological examinations (Figs. 13, 14), and the bacilli (Figs. 15) were uniform. In one case where cocci and bacilli co-existed, the latter were in large numbers; 80,000 being present in each cubic millimetre.

The observations described above were found to point so distinctly to it became desired to ascertain whether the former could give rise to the latter. To ascertain the influence of pus alone, injections of micrococci were made into all of them, and the micrococci, which contained no organisms, it was collected. Histologically (see notes here), in fluids that had been heated for forty-three days at a temperature above 500° Fahr, introduced into a pure subcutaneous spring, and the inoculation was made into the subcutaneous tissues of the back in children, guinea-pigs, white mice, and wild mice. In all, twenty-nine, such injections were made, and a terrible result that no illness or abscess ensued; that the pus was, within a week, the purulent film adhering to the walls of the cavity, and within ten days this film had become totally absorbed, so that no trace of it remained when the animals were killed, and the site of the infection was uncontrollable. If they were killed about the fifth day, it was found as a dry, firm, without any Budding, and so intimately united to the neighbouring tissues that it extended to possess the same texture and consistence, and could not be isolated from them. This indicated that in the animal already mentioned, symptoms of blood-poisoning, lasting from two to five days. The animals refused food, and weighing in a retired place in their cages, were lifeless and apathetic, their coat was discoloured and spotted, and their eyes were kept closed, and the mices showed the purulent concretions and the exudate of the eyes described by Koch in his experiments on septicaemia.

The symptoms became less evident the disease was, and in a case of two or of fever, a prompt in the serum between the cells. Around the site of injection was found a patch of red, varying in size, and having in its centre an abscess containing more pus than the quantity excited with the quantity of micrococci that had been injected. The pus contained many little of micrococci; the number injected, but more numerous, averaging thirteen to eighteen millions per cubic millimetre, instead of two millions as before. The cocci were living and growing, and a deep of the matter injected into another animal produced the same results in it, and it on another animal, and so on. Next in blood-vessels was observable in the transference through a series of animals. The red of the blood-vessels was uniform and distributed throughout the blood and growing, and in some cases even earlier, the animals exhibited a change. They became acutely ill, and seemed much better, but at the spot where the injection had been made, there was found a fluctuating tumour, gradually increasing in size, and containing the same pus as the primary abscess. When they were killed during this second stage, micrococci were found in the heart, lungs, and blood, and the influent of the organisms were found in the abscesses found to be the case, as if their distribution were not perfectly uniform throughout the blood. I was never able to detect their presence in the spleen, kidneys, lymphatic glands, or suprapelvic cavities.

During the discussion on this subject, it was shown that the injection of micrococci was not always a death, even in cases where the micrococci were found in the blood and surrounding structures. Sections through such an abscess-wall showed the existence of a thin layer of granulation tissue, in which could seldom be detected, and which seemed so as a barrier, preventing or diminishing their migration into the blood and surrounding structures. Sections through such an abscess-wall showed the existence of a thin layer of granulation tissue, in which could seldom be detected, and which seemed to act as a barrier, preventing or diminishing their migration into the blood and surrounding structures.

* See, alveolar; one, preputial; and one, præputial abscess.
It is necessary, however, to point out that there seemed to be a difference in the susceptibility of animals exposed to the same experimental conditions of the same species, the same age, and even the same litter: this was observable. The typical course was that above described.

It sometimes occurred that an animal died with signals of blood-poisoning, at the end of the second or beginning of the third day. In two cases where this took place, the micrococci were found in the blood, and the site of injection was marked by a red infiltration, showing the ingress of the cocci already described, with, in one case, incipient purulent destruction in the centre of the knot; while, in the other case, this had seemingly not had time to occur. In both these animals, the dose injected was about half a million, and both were mice.

In one case, that of a guinea-pig, the injection of one minumin produced the symptoms of blood-poisoning, and the local infiltration was felt as a subcutaneous knot; but, after four days, the animal was recovering, and the knot diminishing in size, so as to give promise of lasting completely absorbed, when it was killed on the tenth day. In this case, no cocci were detected in the infiltration; the animal seemed to have had strength enough to render them innocuous by absorption and elimination.* A similar dose of the same pus produced, in an exactly similar animal, the usual results.

In three cases, the local reaction was so intense as to result, not in abscess, but in phlegmasia of the site of injection and overlying skin. In these, the animal seemed to suffer rather less from the symptoms of blood-poisoning; any when they were killed, few micrococci were found in their blood, and the necrosed tissues were surrounded by a strong thick wall of granulation-tissue, presenting, at the places where the inoculation had taken place, a surface like that of a umbilicated, a surface like that of a nodule covered with a thin, whitish, croupy film, in which the micrococci were growing (Fig. 11), though in a feebler and scattered manner, contrasting strongly with the deep, dark-redness of the ordinary course of events.

A diminution of the dose injected rendered the result a subcutaneous abscess, in a diminution in the intensity of the result. One-sixteenth of a minumim, as well as the employment of pus that had been four weeks diluted with blood, gave negative results, the animals showing merely trivial and evanescent symptoms of illness.

For the production of the phlegmasia of one minumim of pus each, in mice as well as in guinea-pigs, produced symptoms of blood-poisoning lasting about three days, after which the animals recovered, and, when killed, exhibited no trace of the injection in the form of either suppuration or abscesses.

On the assumption that a phlegmasia would prove the power of the micrococci, a series of injections were instituted with pus mixed with equal parts of a five-per-cent. water solution of that substance. These were employed on separate animals, as well as on a different part of an animal injected with uninfiltrated pus from an acute abscess; and, in every case, the pus so diluted was found to have been injected in larger quantity, produced no reaction whatever, but disappeared in the rapid and complete way described under the experiments with that from cold abscesses.

Next endeavored to ascertain the temperature capable of destroying the power of the micrococci. Although, in this direction, the experiments were not so numerous as desirable, it may be stated that pus heated to 102° Fahr., or higher, had always failed to excite suppuration. Over a detailed account of the injection experiments, by which the foregoing results were obtained, would be tedious, and occupy much space; but it may be mentioned that 600 micrococci per cubic inch of pus were found in the portal vein of a hog, which had been anesthetized and killed by a blow on the head and chest.

The results, so far as has been gone, may be summed up as follows.

Cold abscesses contain no micrococci, and their pus is harmless. Acute and chronic abscesses always contain micrococci. Pus containing micrococci is resisted by animals if the dose be minute, or if it be injected into the peritoneal cavity. Abscesses of one or two minima injected into the subcutaneous tissue may produce blood-poisoning, or may cause phlegmasia of the site of injection, or may be resisted by an unusually insusceptible animal.

As a general rule, such doses produce acute inflammation, accompanied by blood-poisoning, and ending in abscess.

* Any one who tries injecting pus—a liquid that often causes, and is than explained by the injection having been improperly performed, should find that such a result may occasionally be also explainable by the injection having been improperly performed, before it is too late. The inoculation is given, for instance, to the site of a pustule of the same species, the same age, and even the same litter, this was observed. The typical course was that above described.

III. MICROCOCCI IN WOUNDS AND SUPPURATIONS.

Having studied the connection between micrococci and acute abscesses, it became necessary to extend the field of inquiry, and observe its relation to other forms of suppuration, such as in wounds, ulcers, pustules, and cutaneous. It was specially the purpose of the most recent investigators of micro-organisms, Mr. Watson Cheyne ("Relation of Organisms to Antipathetic Dressings"); Transactions of Pathological Society, vol. xxx), that had arrived at the conclusion that the ordinary forms of micrococci are harmless. What I had observed, as well as what has further to be added, agreed with the facts elicited by him, but necessitated a revision of the conclusions at which he had arrived.

Observations were, therefore, collected regarding the presence of micrococci in forms of suppuration other than abscesses. Examinations of pus in the spuits of bronchitis (one case) and pleurisy (two cases), in carbuncles (nine cases), in gonorrhoea (four cases) and soft chancre (one case), in eczema (one case), and a malignant pus of the larynx, resulted in micrococci being found abundantly present in all, save one case of common acne, running a very chronic course, where they were not detected in about half of the cases examined. In gonorrhoea and soft chancre, they existed in enormous numbers, as in micro-organisms, and gradually became less numerous as the disease approached suppuration. In the malignant pus of the larynx, they were the only organisms detected; and, when injected into a white mouse, revealed it between the second and third day, with all the symptoms of blood-poisoning. The animal having large numbers of them in its blood, and presenting, at the site of injection, a knot of infiltration without suppuration, where the cocci-suppression was extremely dense and well marked (Fig. 11).

A set of control examinations of normal fluids (blood, urine, etc.) and tissues, fully confirmed the now generally received opinion, that no micro-organisms exist in healthy human structures, etc.; and another series of examinations of pathological cases, was carried on. One case of puerperal endometritis (one case), ovarian cysts (six cases), extravasated blood (one case), hematomas (two cases), and vesicles (six cases), yielded one unwarying result, viz., that micrococci never were present in the cases of suppuration, that was absent. Even in normal lochia (two cases), where enormous numbers of all four forms of micro-organisms except spirilla exist, from the ninth hour after delivery onwards, without raising the pulse and temperature above normal, their appearance is the signal for a serious discharge into a liquid which becomes more and more purulent in its nature.

In two cases of puerperal fever where the lochia were examined, the micrococci existed in enormous numbers, and continued present longer than usual, gradually diminishing as the cure was completed in recovery. The remaining series of observations, ninety-six in number, were devoted to the study of wounds and ulcers in various situations and of every conceivable form. The results were singularly corroborative of those obtained by the injection of the pus of acute abscesses.

In cases of extravasation of blood, the blood should be collected for later examination, the troches, where the patient died of blood-poisoning on the eighth day; and where antihistories were not employed, the wound not even having been dressed with chloroform, the lumen, which, did not suppurate, seemed, treated with micrococci; and the blood, examined from day to day, contained in every slide numbers of micrococci. An opportunity of verifying the similarity of the case to those of rapid death in animals, by ascertaining the existence of local cocon-infiltrations by "fast work" examination, was unfortunately denied me.

In another patient, however, where death was averted by amputation, the completeness of the proof compensated for this. A man had sustained a compound dislocation of the ankle-joint, and was treated for a week without Lister's precautions. He became septicaemic, and died on the 13th day from blood-poisoning of the skin. The pus was examined, and micrococci found. A laconic procedure in examining the blood of septic cases is of some consequence. So long as I was content running the blood obtained from the capillaries by pricking the finger, or head, the results obtained were always the same: a few micrococci and one or two that I have never missed, in the blood, but which have been at my disposal since that time, to detect the presence of micrococci in blood-poisoning in every case, and usually without a prolonged search.
From the seventh to the tenth day, when I saw him in consultation, the discharge, which was copious, transparent, but acrid, continued on in the same amount. The patient complained of pain in the wound in the small of the thigh, as well as in the abdomen, below the third rib of the thigh. The hematuria was observed, and, at times, the blood-stained urine was observed. The patient was in a state of anorexia, and could not take food, but the patient was in a state of the same in the micrococci existing in the urine. The patient was in a state of the same in the micrococci existing in the urine.

In every wound even with the most antiseptic applications, were present in large numbers; but no special odor indicated the presence of micrococci. Ulcers (eight cases) and wounds (twenty-eight observations), never treated antiseptically, present many forms of organisms in their discharge. Out of the total, the micrococci exist in preponderant numbers, and are found growing in the film already described (Fig. 11). Where a bagging wound (previous case) contains mosty bacteria and micrococci of two species, both genera, the micrococci become again predominant. As such wounds are healed with a soft spot, out of the wounds treated antiseptically found to contain no evidence of organisms being present. This was a case of the same in the cheek, where the opening had existed for three months, but was soon healed.

No remarkable result was obtained, but in the number of the operative cases, in which only isolated, in pairs, or groups of micrococci, were found in the discharge, often occurring in the granulation tissue, and, in the micrococci, the micrococci are seen to be growing, though no means of culturing it (Fig. 11). In the micrococci, the micrococci come fewer and fewer, until at last, when an isolated one, or perhaps a pair, can be with difficulty detected here and there in the discharge.

On two occasions, I was fortunate enough to obtain a portion of the thinly cut skin from the summit of a pointing acute abscess. The deposit was found to consist of an acellular spot, and it was found to consist of the deposit of the granulation tissue, which was finely employed.

A chronic abscess opened and treated Listerially (seven cases), and a chronic abscess, which had maintained an acellular spot, never over and over again, one of these being an abscess that had been open for five months, and in addition to the abscesses, was studded with acellular spots. When these abscesses are sufficient, when used with great care, to prevent the entrance of any living organism into the wound, the deposit of the granulation tissue, which was finely employed.

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MICROCOCCI EXIST, wherever pus occurs, save in chronic suppurations, and in the urine of persons suffering from gonorrhoea and syphilis. Micrococci in man produce the same varying effects as in animals: they may provoke blood-poisoning without suppuration; they may cause suppuration; or these may be the result of individual and accidental circumstances.

Lastly, there are possibly micrococci that do not produce suppuration.

IV.-CULTIVATION OF MICROCOCCI.

It will not have escaped a critical reader of the preceding parts of this report, that there exist in it statements imperatively requiring further elucidation, or that even appear mutually contradictory. How can it be explained that micrococci are so deleterious when injected, as they are found in lumps of acute abscesses, into the subcutaneous tissue of animals, and yet so harmless on the surfaces of wounds and ulcers? It is, I think, not possible that there exist species of micrococci precisely similar to one another in appearances and growth, and yet widely differing in the effects they are capable of producing. The observation already recorded of the micrococci of micrococci on a cheese-making dressing, covering a wound that was not suppuring, points strongly in that direction. But the observation was an isolated one, and much weight cannot be ascribed to it. The behavior of a wall of healthy granulations, and its power to prevent their penetration in the solution of the difficulties.

The system is incapable of throwing them out, has also been dwelt on, and plainly forms a weighty factor in the solution of the difficulties. But these difficulties are rendered greater by an observation that has been reserved for special mention here. The pus of acute abscesses was found uniform in producing, with the reservations already stated, serious effects in the animals into which it was injected, but pus from wounds was not identical in its effects: Sometimes an abscess in the skin did not produce anything like the same effect as pus from wounds; sometimes it did not; and it was noticeable that, in marked contrast to the former, those abscesses, though rich enough in micrococci, was with difficulty able to produce an occasional suppuration. None of the facts already dwelt upon furnish a sufficiently satisfactory explanation of this. The results, however, of the experiments with cultivated cocci seem to offer the true solution of the difficulty.

In all, one hundred and eighteen cultivation experiments were carried out.

As might have been anticipated, cultivations of pus of dead abscesses (five cases) yielded negative results.

Cultivations of pus of acute abscesses gave at first the most inexplicable and contradictory results. They were grown in cells, prepared by coating a ring, from the upper surface of a slide, moistening the lip of the cup so formed with a weak mixture of oleate of mercury in oil, searching the cup and oil in the flame of a spirit-lamp, to destroy the microorganisms, and dropping on it a cover-glass, also searched in the spirit-flame. The cells were charged with the fluid in which growth was to take place, by removing the cover-glass for an instant and dropping on it from a Luther's flask a minute drop of the liquid. The liquids used were: Ehrlich's fluid, Pasteur's fluid, urino-acetic fluid, oxalate fluid, and blood obtained from the umbilical cord of new-born infants. Ehrlich's and Pasteur's fluids, as also the urine, were put in the flasks, which were cooked with plugs of wax, and then boiled for ten minutes. The other fluids were introduced into the flasks that had been heated for three hours at a temperature under the bunsen, under which the organims, as if from the eye of a newly killed ox, introduced into nascent sepsis by breaking the top in the anterior chamber, was also largely employed. All the liquids were sterilized, and the cultivation were kept for at least a month before being used, and were during that time repeatedly examined as to their freedom from organisms.

Every cultivation was rigidly tested by the employment of control cells.

It was found that some of the micrococci from the pus of acute abscesses grew in these cells, whether they were of the chain or of the group association. More often, however, no growth resulted, the cocci remained unchanged, and it was uneventfully that they died out and totally disappeared. Sometimes they grew in one cell, and not in another. Sometimes they grew in one cell, and failed in one precisely similar; and in short, it was evident that no useful or uniform results were to be obtained by those cultivations. Even when the growth had been most successful, it could only be characterized as poor and scanty, and little tisue of animals.

Variations of temperature were next tried; but with but little result and all degrees, between 59° Fahr. and 100° Fahr., were employed, with varying results, but nothing showing satisfactory. There was plainly some factor of great importance in the method of isolation that had not been taken into account.

Accordingly, a fresh series of cultivations was arranged. On a plate of glass was placed a small bottle, capable of containing half a fluid-ounce. This was covered by a small glass shade and this again by a larger one. The shades fitted accurately the surface of the plate of glass, and allowed the entrance of air, but not of solid particles. This apparatus was put into a warm chamber, and heated for three hours, at a temperature exceeding 100° Fahr. It was then allowed to cool, and removed. A number of these were prepared. On filling them Listerian with pure urine, or with aseptic or ovarian fluid, they remained free from organisms at any temperature in the incubator for any length of time.

They were now used by youths. Into the first was dropped a drop of success pus, collected antiseptically; into the second was put a drop of a liquid containing bacteria, bacilli, and micrococci, and the thin film of sediment, micrococci were found growing and multiplying. The third was, however, by no means abundant or satisfactory; and, like those from wounds, they repeated the same experiments, to produce any effect when injected into animals. The second flask (bacillus staphylococci and leucocies) was (laid, shining, alkaline, and gave off ammonia. Its surface presented sheets or turf of actively moving rods and bacteria. Its lower strata contained those organisms motionless, apparently dead. The third flask (water) was like the second in every way, save that micrococci were found in its deeper strata; The fourth flask was unaltered in any way, and contained no organisms.

Repetitions of these trials yielded always the same results, it is a perplexing question to me, as the cocci were found only in the strata removed from the influence of the atmosphere, they were such as were capable of living without air—anaerobes,—as Pasteur (Bulletine de l'Academie de Medicine, 1856, No. 18) states such. Their cultivation was, therefore, once more attempted in the first mentioned cells, the third flask (water) was like the second in every way, save that micrococci were found in its deeper strata; The fourth flask was unaltered in any way, and contained no organisms.

Finally, I hit on the idea of growing them in eggs, where, I anticipated, they would be in almost identical conditions with those under which they grew in the bodies of animals.

Newly laid eggs were washed in 5 per cent. carbolic acid water; and, under spray, a minute aperture was made in the larger end. One minion of pus from the acute abscess, collected antiseptically under the bunsen, was injected by a long pointed pure pyrung into the albumen at the opposite end of the egg. A piece of protective was laid over the aperture. The egg was wrapped in a dressing, and kept for ten days in the incubator at 59° Fahr. At the end of that time, it was opened, and my expectations were fulfilled. The egg was sweet and the contents were soft; save that the yolk was somewhat broken up, and more or less mixed with the albumen; but the albumen, and sometimes the yolk also, were filled with enormous chains or masses (according to the sort of cocci used) of micrococci, growing quite as luxuriantly as I had ever observed them when experimenting on animals.

A drop of the albumen injected into an animal's back now produced typical abscesses, with all the symptoms and appearances already mentioned; and the animal, on being killed, showed the micrococci in the blood and invading the tissues exactly as had been already obtained by the employment of the pus of acute abscesses. A control of this was repeated three times with variations; the micrococci being cultivated in two eggs in succession for ten days each before being injected into the animal and in two instances the cocci, before being passed through the animal.
REPORT
ON LOCAL LEGISLATION AS TO INFECTIOUS DISEASES.

PRESENTED TO THE PARLIAMENTARY BILLS COMMITTEE OF THE BRITISH MEDICAL ASSOCIATION

BY ERNEST HART,
Chairman of the Committee.


Provisions as to Infectious Diseases in Local Bills of this Session.—In a report bearing the same title as the present, which was submitted to the Parliamentary Bills Committee on the 2nd of February, 1880, I undertook to criticise, from a medical and sanitary view-point, certain provisions made by a number of local authorities in the North of England for the alteration of the Public Health Act, and the addition thereto, for the particular districts concerned, of more or less stringent provisions designed for the more effectual checking of the spread of infection. Of the six local Bills dealt with in that report, five have passed into law substantially as originally introduced; and, with regard to the two affected by these Local Acts, the general public health-law of the country must, therefore, no longer be regarded as unreservedly applicable. The growing desire of local authorities to emancipate themselves from this general law is a matter for very serious consideration; and, therefore, no apology for laying before the Committee, at as early a date as possible, the further alterations now proposed by eight other sanitary authorities (Aberdeen, Barrow-in-Furness, Birkenhead, Bradford, Lincoln, Reading, Salisbury, and Stalybridge), in the Local Bills which will be submitted for the approval of Parliament during the present session. The nature and extent of these alterations will be best judged from an abstract of the principal provisions in each of the local Bills in question.

The Aberdeen Bill provides that, in order to secure more prompt action in dealing with infectious diseases, every medical practitioner practising within the city shall, within twenty-four hours of the same coming to his knowledge, report to the 'Town Council every case of cholera, small-pox, measles, scarlet fever, diphtheria, typhus fever, cerebro fever, and whooping-cough occurring in his practice, under a penalty not exceeding forty shillings (A). For every case so reported, a medical practitioner is to be paid a sum not exceeding two shillings and twopence; and forms, ready stamped for postal transmission, are to be provided by the corporation for the medical reports. The local authority are empowered to alter or vary, from time to time, the list of diseases of which such reports are to be sent. Offence against this clause is punishable by a fine not exceeding forty shillings; and, in case of a continuing offence, by a further penalty not exceeding twenty shillings for each day during which the offence continues.

The Barrow-in-Furness Corporation, following the example set by the example set by the

Jarrow in 1878, desire power (B) to provide temporary shelter or house accommodation for the members of a family in which infectious disease has appeared; (C) to provide or contract for houses for attendance upon persons suffering from infectious disease (and to charge any reasonable rent); (D) to order public or private day-schools, or other places of public assembly in the town, sited as neighbours of affected by infectious disease, to be temporarily closed or suspended; (E) to order any shop, dairy, or other place for the sale or storage of articles of food or drink for consumption in public, or articles liable to detain infectious disease, to be temporarily closed, whenever, from the suspicion of infectious disease in such shop, dairy, or other place, or in respect of a connected or neighbour’s, it is necessary to close it. The same provisions are to be made respecting infectious diseases in the town, sited as neighbours of affected by infectious disease, to be temporarily closed or suspended; (E) to order any shop, dairy, or other place for the sale or storage of articles of food or drink for consumption in public, or articles liable to remain infectious disease, to be temporarily closed, whenever, from the suspicion of infectious disease in such shop, dairy, or other place, or in respect of a connected or neighbour’s, it is necessary to close it.

For greater convenience, I have given to each of the clauses to which I shall have to refer a distinctive letter, so that it can be more easily traced.