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Heiman F.L. Wertheim
Medical Microbiology
L348
Erasmus MC
Dr Molewaterplein 40
3015 GD Rotterdam

Tel: 0104633510
Fax:
E-mail: h.wertheim@erasmusmc.nl
Budget: 2230

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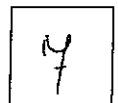
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Heiman F.L. Wertheim Erasmus MC
Medical Microbiology
Dr Molewaterplein 40
3015 GD Rotterdam

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REPORT
UPON
MICRO-ORGANISMS IN SURGICAL
DISEASES.

Presented to the Scientific Grants Committee of the
British Medical Association.*

By ALEXANDER OGSTON, M.D.,
Surgeon to the Royal Infirmary, Aberdeen.

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 not 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 complicated forms of disease? And what difference is there in the effects of the different forms 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 alone—the micrococcus. 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-shaped; 2. The bacillus, or rod-shaped; 3. The bacterium, 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 innocent organism. The most recent investigations, those of the Committee of the Pathological Society (*Transactions of the Pathological Society*, vol. xxx), leave 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 recognise 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; cultivations; control experiments with every step; and utilising the applications of the Listerian system,—were all employed with the utmost minuteness and regularity. But the main dependence was placed on the methods recently introduced by Koch of Wollstein for the demonstration of micro-organisms. This observer has asserted (*Ätiologie der Wundinfektionskrankheiten*, 1878) that, by the use of aniline-staining, oil-immersion objectives, and certain arrangements of light, it is possible to ascertain the existence of micro-organisms in the tissues, etc., even when they exist in an isolated form. Save in regard to Koch's carbonate of potash process, which did not succeed in my hands, I am able to affirm the correctness of his assertions. His processes were employed in the following manner.

In observing tissues, the structures were, immediately on the death of the animal, placed for forty-eight hours in methylated spirit. They were then imbedded in paraffine whose melting temperature was 110° Fahr.; and sections were made with a hollow-ground razor. After being soaked for two hours in a solution of methyl-aniline-violet of the strength of half a grain to the fluid-ounce of water, they were placed for two minutes in dilute acetic acid, prepared by adding four minims of glacial acid to a fluid-ounce of water; then transferred for sixty seconds into methylated spirit; then for sixty seconds into pure alcohol; and finally for two minutes into oil of cloves; after which they were placed on a slide, and mounted in a drop of commercial Canada balsam. The liquids employed were themselves carefully examined for organisms, and found to contain nothing. All aniline solutions, even after filtration, contain minute floating particles of the dye, showing Brownian movements; but after a short time they sink

* With lithographic illustrations.

† Throughout the present paper, the term "blood-poisoning", though inapt, is used as including pyæmia, septicæmia, and other infective processes.

to rest; and are then seen to be amorphous granules of the pigment. Many of the aniline dyes were found more or less useful. Eosine, fuchsine, and the browns, blues, and yellows, were tested in succession, but found inferior to the methyl-aniline-violet; and even among the samples of the violet met with in commerce, some were found superior to others. It stains the sections of an uniform deep violet; but the colour becomes gradually fainter as they are passed through the other fluids; until at last they possess 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 alcohol or acetic acid removes all colour; and oil of cloves also extracts it, though less rapidly; so that it is of some consequence to use care in preparing the sections. Slight variations from the above procedure make little difference to the result,—are, 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-jelly, etc.; and the sections will not keep. Hence the balsam must be used pure.

In observing liquids of some thickness, such as pus, the thinnest possible film is spread with a needle on a slide, and immediately dried over a spirit-lamp. To tint it, the same aniline solution is employed (half a grain to an ounce). The slide is first heated so as to render the film more adherent, and a drop of the dye is placed upon it. It is left for sixty seconds; then washed off by a gentle stream of water; and the film, now deep violet, is again dried over the lamp. While still warm, a drop of Canada balsam is placed upon it; a warmed cover-glass is laid on, and held by a clip until the slide is cold and ready for examination.

Some liquids, such as blood and urine, dissolve off the slide, if left for sixty seconds exposed to the water of the dye. They require to be treated as follows. A thin film of them is prepared as before. After being warmed over a spirit-lamp, a drop of aniline solution, of the strength of two grains to the fluid-ounce, is quickly spread over the film 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 objects so prepared, the micrococci are unmistakable. They are very deeply stained in comparison with the surrounding objects, 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 often require more 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 by me as follows. The slides were examined by a microscope fitted with a one-eighteenth of an inch oil-immersion obtained from Zeiss of Jena; the tube of the microscope being 155 millimètres in length; and the eye-pieces employed being 2, 4, and 5 of Zeiss's manufacture. The substage condenser was that of Professor Abbe, without any diaphragm; the illumination was good gaslight, concentrated by a blue-tinted bull's-eye 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 renders them as 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 extracted from their peripheral layers, and left only in the centre. Professor Cossar Ewart, an eminent authority in questions regarding micro-organisms, did me the favour to look over my preparations, and was satisfied that the bodies in question were what I had supposed them to be.

Wolf (*Centralblatt für Chirurgie*, 1879, No. 51) has recently stated, as an objection to Koch's 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. Micro-organisms in disease do not exist in the form of scattered, isolated, haphazard bodies; they are growing, and that actively; and, as will be shown further on, they grow in such a definite recognisable form that their purpose, not to mention their existence, is quite plain; and it is impossible to confound them with any such granular bodies as those alluded to by Wolf. Indeed, micro-organisms, if found isolated in such a way as to leave a vestige of doubt 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

of the investigation are discussed, that they are too numerous to be so reported on without adding unduly to bulk at the expense of lucidity.

II.—MICROCOCCHI IN INFLAMMATION.

It is by no means easy to obtain any single form of organism pure from admixture of others. Micrococci are most readily obtained pure and unmixed 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. Koehler of Bern (*Zur Ätiologie der acuten Entzündungen*; *Arch. für Klin. Chir.* Band xxiii), in a paper upon Osteomyelitis and Strumitis, published in 1878, had 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 determining the reasons 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 months, proceeding from chronic carious disease of bone, scrofulous lymphatic glands, and such like. In none of them were any organisms found.

Four were somewhat chronic 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 hectic—such as tonsillitis, phthisis, scarlatina, erysipelas, typhoid fever, and diphtheria. All of these contained micrococci, and were evidently the same as the next form.

Lastly, sixty-five were acute abscesses, whose duration could be measured by days, from all parts of the body. Everyone one of these contained micrococci.

All the abscesses had been hitherto unopened, 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. But in many of them the pus was obtained for me, and prepared according to printed directions by several medical friends, among whom I have especially to thank Drs. Hall, Jackson, Macquibban, Frank Ogston, Alex. Reith, Robertson, and Smith-Shand, of Aberdeen; Mr. Dalzell, of Aberdeen; and Drs. Craven, of Thurso; Collins of Bervie; Edmond of Stonehaven; Jamieson of Peterhead; Keith of Aboyne; Lyon of Peterculter; Milne of Cluny; Robb of Portsoy, and Shearer of Ballater.*

The acute abscesses were—

Of the Hand	18	Of Scalp	2
Mammary	8	Gluteal	1
Cervical	10	Perineal	1
Alveolar	8	Popliteal	1
Prepatellar	3	Of Abdominal Wall	1
Axillary	3	Temporal	1
Of Ankle	2	Of Arm	1
Post Aural	2	Not specified	3

The pyæmic—

In the Leg after Erysipelas	1
„ Neck after Tonsillitis	1
„ Thigh after Typhoid Fever	1
„ Axilla after Phthisis	1

The cold abscesses were—

Cervical	3	Of Elbow	1
Of Foot	2	Sternal	1
Of Thigh	2	Lumbar	1
Mammary	1	Chronic Pyothorax	1
Of Abdominal Wall	1		

It was impossible that micrococci in any numbers could have fallen into the pus in the few 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 all the sixty-nine acute and pyæmic abscesses, and had been absent in all the "cold" abscesses. The forms in which the organisms showed themselves corroborated this. They had been growing. Sometimes they

* The number of abscesses examined was subsequently increased to 100; the results, however, remaining the same. In addition to the gentlemen named above, my thanks are due to Dr. Mackenzie Booth, of Aberdeen; Dr. Walker, of Frickheim; Dr. Macconnachie, of Bervie; and Dr. Williams, of Tarland.

† These two forms are hereafter always classed together as "acute".

were seen as chains (Fig. 2), of from three or four cocci, up to much larger numbers. Generally five or six cocci were strung together; often ten to twenty were found; and in some specimens they existed as extremely long chains winding about or coiled up in the pus, and equivalent in their extent to twenty or thirty pus-corpuses, placed in a row. In one specimen, a chain consisting of 321 cocci was counted, and this was by no means the longest one observed. The chain-shape seemed to be the only form present in certain of the specimens—everything was in chains; and even where a group was visible it was seen to consist of chains interwoven with each other, and entangled into a mass (Fig. 6).

In other specimens, again, no chains were seen at all; the cocci were grouped, like the roe of fish, into clusters where there was neither beginning nor end (Figs. 1 and 5).

These arrangements were evidently due to the mode of growth. Both forms grew and multiplied by division of the coccus into two equal parts which separated, became themselves spheres, and again divided, and so on. In the chain-form, division occurred in only one direction, through a plane midway between two given poles, so that a pair of cocci growing formed a chain of four; this grew into a chain of eight, and so on, indications of this constant growth in one direction being evident (Fig. 2) wherever chains of any length existed. In the grouped form fission took place in any direction, a single coccus seemingly dividing into two, three, or four cocci, and a continuance of this forming the groups. Many of the masses had evidently been 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 into fours, or even, though more rarely, into threes (Figs. 1 and 5). The groups formed by this mode of division had no appearance of being built up of chains.

Micrococci present a capsule surrounding each ball, and binding them together into chains and groups. It appears as a glistening 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, the groups, instead of showing transparent intervals between the cocci as in Fig. 5, the usual arrangement, had an amount of colour between them which depended either on their being piled up one behind another, or on the existence of a stainable interposed substance, giving them the aspect of grape-clusters (Fig. 1).

In some cases, unusually large oval cocci (Fig. 8) existed, chiefly in pairs.

For 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 groups only, and sixteen 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 subsequently, 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 1/1480th of a millimetre, or even less.

They possessed spontaneous movements. Isolated cocci were agitated with oscillatory jerking motions on their own axis, with a slight tendency to be jerked out of the place they occupied; pairs showed a somewhat rhythmical movement around their bond of union, that could best be likened to the motions of a shillelagh; and the chains and groups 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 observed for twenty-five minutes, moved in that time three times its own length, working its way through a motionless mass of albumen. It moved chiefly endwise, and the rate of progress seemed uniform, as it took eight and a half minutes to move once its own length. No flagella could be 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, only after they were dried and stained. The hæmacytometer was used to calculate the number of pus-cells. A limited number of specimens of pus unmixed with blood were selected for this purpose, as many samples coagulated so firmly that they could not be employed. Ten samples were taken of pus from acute abscesses, and five of pus from cold abscesses. Of each sample, forty estimations were made by

Hawksley's Gowers' instrument, constituting a total of 400 in the case of acute, and 200 in that of cold abscesses. The figures were—

Average Number of Pus-cells per Cubic Millimetre.	
Acute.	Cold.
387,500	287,500
905,000	337,500
540,000	382,500
750,000	265,000
1,112,750	600,000
1,280,000	
737,500	
935,000	
1,425,000	
1,105,000	

The average, therefore, 917,775 pus-corpuscles per cubic millimetre in the case of pus from acute, and 395,500 in pus from cold abscesses. Accordingly, 900,000 was assumed to be the average number present in each cubic millimetre of pus from acute abscesses; and from that it was easy to count the micrococci by finding out their numerical relation to the corpuscles. In the specimens where this was noted, it was found that—

1	contained about 45,000,000 of micrococci per cubic millimetre.
2	" " " " 18,000,000 " " " "
2	" " " " 9,000,000 " " " "
3	" " " " 4,500,000 " " " "
4	" " " " 1,800,000 " " " "
1	" " " " 1,200,000 " " " "
7	" " " " 900,000 " " " "
1	" " " " 818,000 " " " "
1	" " " " 450,000 " " " "
1	" " " " 337,000 " " " "
1	" " " " 270,000 " " " "
3	" " " " 180,000 " " " "
6	" " " " 90,000 " " " "
3	" " " " 60,000 " " " "
7	" " " " 45,000 " " " "
1	" " " " 30,000 " " " "
2	" " " " 22,500 " " " "
5	" " " " 18,000 " " " "
1	" " " " 15,000 " " " "
1	" " " " 1,500 " " " "
1	" " " " 1,125 " " " "
2	" " " " 900 " " " "

giving an average of 2,901,025 micrococci in each cubic millimetre.

The variations were enormous: It will be observed, for example, that one specimen contained forty-five millions, while two others contained only 900 per cubic millimetre. It seemed also to be the case, and possibly this may explain the variations, that they were not equally distributed throughout the pus. A drop taken from one part of the pus showed more, from another part fewer; they seemed more numerous in the lower than in the higher layers of the pus, but even there were not uniformly distributed. Still, even where there were comparatively few, in not a single instance did a slide of pus from an acute abscess, when examined with care, fail to show abundant evidence of their existence, while in most cases they formed as prominent an object as the pus-corpuscles themselves.

It now and then happened that other organisms co-existed with the micrococci. In three cases* bacilli; in two alveolar abscesses, bacilli, and bacteria; and in three alveolar abscesses, bacilli, bacteria, and spirilla were present, but the micrococci were the only constant organisms.

Micrococci in pus existed almost always in the serum between the cells (Figs. 5, 13, and 15), the chain-cocci especially so; but it occasionally happened that the grouped cocci were found in masses on (or possibly in) the cells (Figs. 3 and 14). Such inhabited cells were mostly large masses of protoplasm, without a nucleus (Fig. 14). The bacteria were mostly collected in or on cells (Fig. 13), more rarely intercellular (Fig. 15). The bacilli were generally intercellular (Fig. 14); and the spirilla (Fig. 15) were uniformly so.

In one case where cocci and bacilli co-existed, the latter were in larger numbers; 180,000 being present in each cubic millimetre, against 22,500 cocci.

The observations detailed above were found to point so distinctly to more than an accidental relation between micrococci and abscess, that it became desirable to ascertain whether the former could give rise to the latter. To ascertain the influence of pus alone, injections were first of all made with that from cold abscesses, which contained no

organisms. It was collected listerially (*sit venia verbo*) in flasks that had been heated for over three hours at a temperature above 260° Fahr. Introduced under spray into a pure subcutaneous syringe, quantities varying from one to ten minims were injected into the subcutaneous tissue of the back in chloroformed guinea-pigs, white mice, and wild mice. In all, twenty such injections were made, with the invariable result that no illness or abscess ensued; that the pus was, within a week, dried up into a film pervaded with living cells; and that 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 injection was undiscoverable. If they were killed about the fifth day, it was found as a dry film, without surrounding reaction, and so intimately united to the neighbouring tissues that it seemed to possess the same texture and consistency, and could not be isolated from them. This indicated that pus *per se*, at least as existing in cold abscesses, is innocuous; and the results correspond with those obtained by former experimenters.

But a very different effect was produced when similar injections were made with pus containing micrococci. In every instance, with the qualifications to be presently made, well-marked disease was set up. Quantities varying from one to three minims produced, in the animals already mentioned, symptoms of blood-poisoning, lasting from two to five days. The animals refused food, sat cowering in a retired place in their cage, were listless and apathetic, their coat was disordered and sometimes wet, their eyes were kept closed save when startled, and the mice showed the purulent conjunctivitis and glueing together of the eyelids described by Koch in his experiments on septicæmia. These symptoms became less marked towards the end of the first week or five days. If the animal were killed during this stage, the blood in its right heart was found to contain micrococci; single, in pairs, and in short chains of six or fewer, swimming in the serum between the cells. Around the site of injection was found a patch of red infiltration, varying in size, and having in its centre an abscess containing more pus than corresponded with the quantity that had been injected. The pus contained myriads of micrococci of the same nature as those 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 drop of the matter injected into another animal produced the same results in it, and it on another animal, and so on. No increased virulence was observable in the transferece through a series of animals. The red infiltration around the abscess showed the micrococci invading the neighbouring tissues, penetrating between their cells, and in colonies or chains gradually decreasing in size, pushing their way for a considerable distance into the structures in the vicinity. The form of the colonies seemed to be determined by the cocci injected. Chain-cocci grew as in Fig. 12, still preserving their chain-arrangement; while grouped cocci formed cloud-like masses and colonies, such as those depicted in Figs. 7 and 17. In the invaded districts, the tissues seemed to have been acted on—cauterised, as it were—by the cocci, being more vitreous or waxy in aspect than those beyond the invaded territory. The micrococci in the heart-blood were comparatively few, and somewhat variable in number; they were generally found in each specimen mounted, but now and then this was not the case, as if their distribution were not perfectly uniform throughout the blood. I was never able to detect their presence in the lungs, liver, spleen, kidneys, lymphatic glands, or suprarenal capsules.

After five to seven days had elapsed, and in some cases even earlier, the animals exhibited a change. They became active again, threw off their lethargy, and seemed well; but, at the spot where the injection had been made, there was found a fluctuating tumour, gradually increasing in size, and presenting all the signs of being an ordinary abscess. When they were killed during this second stage, micrococci were more rarely found in the heart-blood, and the infiltration of the organisms into the tissues around the abscess no longer existed, having been replaced by a firm thick wall of granulation-tissue, in which micrococci could seldom be detected, and which seemed to act as a barrier, preventing or diminishing their migration into the blood and surrounding structures. Sections through such an abscess-wall showed the existence on its inner surface of a thin layer of croupy appearance (Fig. 7), in which, here and there, colonies of the micrococci were growing, but were seemingly powerless to penetrate further. The abscess-cavity contained pus filled with micrococci as before, but not in greater numbers than in the earlier stage. In the viscera of animals killed during this stage, I again failed to detect any organisms.

* It need not be constantly repeated, that the utmost antiseptic precautions were observed in the whole of the experiments.
† In every animal experimented on, whatever was the result of the experiment, the injection-site, lungs, kidneys, and heart-blood, were submitted to a careful microscopical examination; and frequently nearly all the organs in its body were so examined.

* One, alveolar; one, prepatellar; and one, perineal abscess.

It is necessary, however, to point out that there seemed to be a difference in the susceptibility of animals exposed to the same experiment. Even in those of the same species, the same age, and even the same litter, this was observable. The typical course was that above described.

But it sometimes occurred that an animal died with signs 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 ingrowth 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 minim, and both were mice.

In one case, that of a guinea-pig, the injection of one minim 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 being 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 sphacelus of the site of injection and overlying skin. In these, the animals seemed to suffer rather less from the symptoms of blood-poisoning; and, 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 slough was detached, a surface like that of an ulcer covered with a thin, whitish, croupy film, in which the micrococci were growing (Fig. 11), though in a feeble and scattered manner, contrasting strongly with their behaviour in the ordinary course of events.

A diminution of the dose injected resulted, as a rule, in a diminution of the intensity of the result. One-sixteenth of a minim, as well as the employment of pus that had been very much diluted with blood,† gave negative results, the animals showing merely trivial and evanescent symptoms of illness.

Four injections into the peritoneal cavity of one minim 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 adhesions.

On the presumption that carbolic acid would destroy the power of the micrococci, a series of injections were instituted with pus mixed with equal parts of a five-per-cent. watery solution of that substance. These were employed on separate animals, as well as on a different part of an animal injected with unmixd pus from an acute abscess; and, in every case, the pus so disinfected, though 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.

I next endeavoured to ascertain the temperature capable of destroying the power of micrococci. Although, in this direction, the experiments were not so numerous as is desirable, it may be stated that pus heated to 130° Fahr., or higher, hitherto always failed to excite suppuration.

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 68 injections were made, 28 of them with unaltered acute pus, 4 into the peritoneal cavity, 20 with cold abscess-pus, and 16 as control experiments, with carbolised or heated pus, and pus diluted with blood, or in minute quantities.

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

Cold abscesses contain no micro-organisms, and their pus is harmless.

Acute and pyemic abscesses always contain micrococci.

Pus whose micrococci are killed by carbolic acid or high temperatures is harmless.

Pus containing micrococci is resisted by animals if the dose be minute, or if it be injected into the peritoneal cavity.

Doses of one or two minims injected into the subcutaneous tissue may cause death by blood-poisoning, or may cause sphacelus 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 coagulates, and is then injected with difficulty—will understand that such a result may occasionally be also explicable by the injection having been imperfectly performed.

† Professor Lister, at the International Medical Congress at Amsterdam in September 1879, stated that he had experimentally found that blood, like a living tissue, resists the development of micro-organisms.

III.—MICROCOCCI IN WOUNDS AND SUPPURATIONS.

Having studied the connection between micrococcus and acute abscess, it became necessary to extend the field of inquiry, and observe its relation to other forms of suppuration, as found for instance in wounds, ulcers, pustules, and catarrhs. It was specially needful to do so, as one of the most recent investigators of micro-organisms, Mr. Watson Cheyne ("Relation of Organisms to Antiseptic Dressings", *Transactions of Pathological Society*, vol. xxx), 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 abscess. Examinations of pus in the sputa of bronchitis (one case) and phthisis (two cases), in pustules (nine cases), in gonorrhœa (four cases) and soft chancres (one case), in syccosis (one case), and in a malignant pustule of the lip, 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 the pustules examined. In gonorrhœa and soft chancre, they existed in enormous numbers, along with other micro-organisms, and gradually became less numerous as the diseases approached cure. In the malignant pustule of the lip, they were the only organisms detected; and, when injected into a wild mouse, killed 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 coccus-infiltration was extremely dense and well marked (Fig. 16).

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 fluids, in hydrocele (two cases), ascites (one case), ovarian cystoma (six cases), extravasated blood (one case), hæmatoma (two cases), and vesicles (six cases), yielded one unvarying result, viz., that micrococci never were present in them where suppuration 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 change of the red serous 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 cases ended in recovery.

The remaining series of observations, ninety-six in number, were devoted to the study of wounds and ulcers in every situation and of every sort, embracing wounds that killed by septicæmia (one case), wounds where septicæmia terminated in recovery (one case), operation-wounds that had been treated Listerially and remained aseptic throughout (eleven cases), operation-wounds where the antiseptic treatment failed (eight cases), chronic abscesses that had been dressed Listerially and had remained aseptic (eight cases), similar abscesses where Lister's treatment had failed (eight observations), and wounds (twenty-eight observations) and ulcers under other methods of treatment and in all stages. The results were singularly corroborative of those obtained by the injection of the pus of acute abscesses.

In a case of extirpation of the thyroid gland for goitre compressing the trachea, where the patient died of blood-poisoning on the sixth day, and where antiseptics were not employed, the wound not even having been mopped with chloride of zinc, the wound, which did not suppurate, teemed with micrococci; and the blood,* examined from day to day, contained in every slide numbers of micrococci. An opportunity of verifying the similarity of this case to those of rapid death in animals, by ascertaining the existence of local coccus-infiltrations by *post mortem* examination, was unfortunately denied me.

In another patient, however, where death was averted by amputation, the completeness of the proof compensated for this deficiency. A man had sustained a compound dislocation of the ankle-joint, and was treated for a week without Lister's precautions. He became septic-

* The mode of procedure in examining the blood of septic man is of some consequence. So long as I was content to examine the blood obtained from the capillaries by pricking the finger or hand, the results obtained were almost always negative; but after I became aware of the proposal of Hüter to observe the human circulation *intra vitam* on the inner surface of the lower lip by the microscope, and utilised this knowledge by opening a small arteriole or venule in that region, and, with proper precautions, mounting the blood so obtained, I have never failed, in the seven cases which have been at my disposal since that time, to detect the presence of micrococci in blood-poisoning in every slide, and usually without a prolonged search.

æmic. From the seventh to the tenth day, when I saw him in consultation, the discharge, which was not purulent, but serous, contained numerous micrococci. He came into hospital, and the limb was amputated on the tenth day, at the lower third of the thigh. Around the margin of the wound in the ankle, abundant reticular infiltration of colonies of cocci was observed; and, far up the leg, in the blood-stained and oedematous subcutaneous tissue, in its deepest part, lying in contact with the aponeurosis, the same infiltration of micrococci existed everywhere. The torn saphena vein contained pus for two inches upwards from the ankle, and this was the only pus found in the case. Above this, the vein was plugged by a firm coagulum; and bacilli, with multitudes of micrococci, existed in the pus. The clots in and around the ankle-joint were full of gigantic sheets and groups of cocci, mostly free, but sometimes in or on large non-nucleated masses of protoplasm (Fig. 10). No cocci were discovered in the popliteal lymphatic gland; but in the blood taken by a student, at my request, from the popliteal vein, at the moment of operation, and at once mounted, they existed in considerable numbers, and were evidently being carried off into the general circulation. In one of the amputation-flaps an oedematous spot was left; and, probably from it, although the operation and treatment were both minutely antiseptic, the wound became impure and suppurated, the pus containing micrococci and bacilli, which were also thrown off in great numbers in the urine* (Fig. 4). These two cases seem to be analogous to the rapidly fatal cases in animals where death ensues from blood-poisoning ere suppuration had time to be set up.

When an acute abscess is opened and treated Listerially (seven cases), the micrococci, at first abundant, gradually become fewer, and, instead of being found in large groups or chains, occur only isolated, in pairs, or in fours, or in short chains of threes, fours, and fives. The abscess is changed into a healing ulcer by the contraction and the growing granulation-tissue, and on the surface a thin whitish film is observable. If an opportunity occur of removing and examining a portion of such an ulcer (three cases), this film is found to consist of vitreous altered tissue continuous with the healthy tissues beneath, and in it the micrococci are growing, though by no means luxuriantly (Fig. 11). As the ulcer heals, the micrococci become fewer and fewer, until at last, when the granulations are bright red, clean, and level with the surface, only 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 thinned skin from the summit of a pointing acute abscess. There was no unusual coccus-infiltration visible in it, and the appearances indicated that pointing takes place by an absorption of the granulation-wall at one point, unaided by any special process in which the micrococci are actively employed.

A chronic abscess opened and treated Listerially, or a similarly treated operation-wound that has maintained an aseptic course, never shows any organisms whatever. I have examined many such cases over and over again, one of them being an abscess that had been open for five months, and invariably with the result that they were totally free from organisms of any sort. I am satisfied that Lister's spray and dressings are sufficient, when used with great care, to prevent the entrance of any living organism into a wound. But this statement has its limits: careless dressing is, of course, punished by failure in obtaining this result; and, in certain regions of the body, as the axilla, a proportion of the operations, however carefully performed, have, in my experience, become septic from the development of micrococci which had, I presume, existed in the large sweat or sebaceous glands, where they had been sheltered from the action of the carbolic acid. In the scrotum (two cases), I have not seen an operation-wound maintained free from organisms, whatever care had been exercised. They were present in the wound, in large numbers and of many sorts, within twenty-four hours. The large sebaceous glands existing there furnish a sufficient explanation of this.

Where the skin is thick, as about the heel, it is often necessary to dress the part Listerially and use frequent carbolic washings for some

* It seems probable that the kidneys are the chief agents in eliminating micro-organisms from the system. I have already stated that I was never able to detect micrococci in the kidneys of the animals experimented upon, and I also failed in the few cases where their urine was examined; but in man, by the process mentioned in the introduction, I have not failed, since my attention was directed into this channel, to find abundant micrococci, and even more abundant bacilli, in urine drawn off from an early abscess. Having only lately attended to this, I have had but four or suitable cases at my disposal, but in them the organisms were abundant; and in one micrococci in the urine was used as confirming the diagnosis, and deciding on the exploratory operation by which the pus was found and evacuated. In the later stages of abscess and suppuration, the establishment of a barrier of granulation tissue might be expected to diminish their numbers, or even put a stop to their occur-

days previous to an operation, else an aseptic result may not be obtained. Operations that have been conducted Listerially, but where a probable error in the antiseptics has led to the occurrence of deep suppuration, are exactly like a spontaneous acute abscess. Two such cases were observed (failure of the spray), both being excisions of the mamma; and in both the pus, on its evacuation, presented precisely the characters of abscess-pus in containing only micrococci.

In every wound which smelt suspiciously, bacteria or bacilli were present in large numbers; but no special odour indicated the presence or absence of micrococci.

Ulcers (eight cases) and wounds (twenty-eight observations), never treated antiseptically, present many forms of organisms in their discharge. On flat surfaces, where the discharge does not stagnate, micrococci exist in preponderating numbers, and are found growing in the film already described (Fig. 11). Where a bagging wound (three cases) or a deep sinus is present, the discharge is apt to be foetid, and contains mostly bacteria and bacilli, the cocci being proportionally fewer; but where an incision converts the pouch into a superficial wound (two cases), the micrococci become again predominant. As such wounds and ulcers heal, the organisms become fewer, until, finally, in a sinus or ulcer almost cicatrised, it may be difficult to find them. They exist, however, to the very end; and in only a single case was discharge from a wound not treated antiseptically found to contain no evidence of organisms being present. This was a case of sinus of the cheek, where the opening had existed for three months, but was so small and valvular that possibly the sinus may never have been septic.

It was remarkable how certainly any virulence or acuteness of the suppurative process was accompanied by an increase in the numbers and signs of quick growth of the micrococci present, and a diminution in these respects by their diminished numbers and activity; so that, in a given case, from the violence of the appearances, it was quite possible to form a very accurate estimate of the microscopic appearances that were to be found in the discharge.

Once micrococci have gained access to a wound, it is not easy to eradicate them. Ordinary Lister's dressings will not do so (eight cases). After weeks of dressing with carbolic lotion (three cases); carbolic oil, 1:16 and 1:8 in strength (eight cases); after the use of dressings with boracic lint (four cases), salicylic acid (one case), and chloralum (one case), all carefully and thoroughly applied, they were found in the wounds and ulcers in nearly as great numbers as before; and it was clear that these applications, at least as ordinarily employed, although generally sufficient to kill bacteria and bacilli, are powerless to eradicate the micrococci. The only way in which I succeeded in destroying them in wounds, where they had once established themselves, was by cauterisation with strong solution of chloride of zinc, or by strong frictions with five per cent. watery solution of carbolic acid—the ordinary 1:20 lotion.

A confirmation of the late Mr. Callender's statements regarding the success attending the over-distension of abscesses by carbolised water, was met with in two cases of opened abscesses, where the inner wall was well rubbed with carbolic lotion, and where immediate healing was obtained under circumstances where it seemed otherwise impossible. The principle is identical in both cases, the success being explicable on the supposition that the energetic application of the antiseptic destroys the micrococci in the inner layer of the abscess-wall. Mere syringing out of the interior of a newly opened abscess with carbolic lotion did not produce the same effect.

The presence of micrococci, however, does not always imply suppuration. In one case of operation for flat-foot, performed and dressed Listerially, the dressing, which had not been changed for a considerable time, was observed on its removal to have a markedly cheesy smell. It was not putrid; and the wound, which was superficial, looked aseptic—that is to say, its discharge was merely serous, leaving a white pulp upon the protective quite unlike pus; and on its surface were partially decolorised blood-clots and portions of the catgut sutures, and these were being absorbed by the growing tissues beneath—so that the wound was healing "unter feuchtem Schorfe", as the Germans say. Yet the pulpy matter upon the protective contained organisms, and among them some micrococci, as shown in Fig. 9. This was the only cheesy-smelling dressing that I had occasion to observe.

The results of the observations on wounds and suppurations other than abscess may be thus summed up.

Suppurating wounds contain micrococci, whose numbers and activity are proportionate to the intensity of the suppuration.

Listerian dressings prevent micro-organisms from gaining access to wounds.

Micrococci in wounds withstand most antiseptic applications.

Where no micrococci are present in wounds, no pus is produced; the discharge is serous.

Micrococci exist wherever pus occurs, save in chronic suppurations, such as cold abscess, chronic acne vulgaris (?), etc. Micrococci in man produce the same varying effects as in animals; they may produce blood-poisoning without suppuration; they may cause suppuration; or they may be resisted by strong individuals under favouring 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 the pus of acute abscesses, into the subcutaneous tissue of animals, and yet are so harmless on the surfaces of wounds and ulcers? It is no doubt possible that there exist species of micrococci precisely similar to one another in appearance and growth, and yet widely different in the effects they are capable of producing. The observation already recorded of the presence of micrococci on a cheesy-smelling dressing, covering a wound that was not suppurating, points somewhat in that direction. But the observation was an isolated one, and much weight cannot at present be attached to it. The behaviour of a wall of healthy granulations, and its power to prevent their penetration in such numbers that 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 whom it was injected; but pus from wounds was not identical in its effects. Sometimes an abscess resulted, sometimes it did not; and it was noticeable that, in marked contrast to the pus of abscesses, that of wounds, though rich enough in micrococci, was with difficulty able to produce an occasional suppuration. None of the facts already dwelt upon furnished 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 cold abscesses (five cases) yielded uniformly negative results.

Cultivations of pus of acute abscesses gave at first the most inexplicable and contradictory results. They were grown in cells, prepared by cementing a ring of glass to the upper surface of a slide, moistening the lip of the cup so formed with a weak mixture of oleate of mercury and olive oil, scorching the cup and oil in the flame of a spirit-lamp, to destroy all organisms, and dropping on to it a cover-glass, also scorched 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 Lister's flask a minute drop of the liquid. The liquids used were: Cohn's fluid, Pasteur's fluid, urine, ascitic fluid, ovarian fluid, and blood obtained from the umbilical cord of new-born infants. Cohn's and Pasteur's fluids, as also the urine, were put in the flasks, which were corked with plugs of cotton-wool, and then boiled for ten minutes. The other fluids were introduced with antiseptic precautions into flasks that had been heated for three hours at a temperature exceeding 270° Fahr. Aqueous humour from the eye of a newly killed ox, introduced into purified sealed pipettes by breaking off the point in the anterior chamber, was also largely employed. All the liquids used for cultivation were kept for at least a month before being used, and were during that time repeatedly examined as to their freedom from organisms.

It was found by experiment that these methods afforded sufficient protection against the accidental introduction of organisms; for at least nine out of every ten cells charged in the laboratory with these fluids, and kept for ten days in the incubator, at a temperature of 98° Fahr., remained free from all micro-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 variety. More often, however, no growth resulted, the cocci remained unchanged, and it not unfrequently happened that they died out and totally disappeared. Sometimes they grew in one liquid, and not in another; sometimes they grew in one cell, and failed in one precisely similar; and, in short, it was speedily evident that no useful or uniform results were to be obtained by these cultivations. Even where the growth had been most successful, it could only be characterised as poor and scanty compared with the progress it seemed to make in the subcutaneous tissues of animals.

Variations of temperature were next tried, but with no better result; and all degrees, between 50° Fahr. and 100° Fahr., were employed, without leading to anything satisfactory. There was plainly some factor at work that had not been taken into account.

Accordingly, a fresh series of cultivations was arranged. On a piece of plate-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-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 260° Fahr. It was then allowed to cool, and removed. A number of these were prepared. On filling them Listerially with pure urine, or with ascitic or ovarian fluid, they remained free from organisms at any temperature in the incubator for any length of time.

They were now used by fours. Into the first was dropped* a drop of coccus pus, collected antiseptically; into the second was put a drop of a liquid containing bacteria and bacilli, but no micrococci; the third was either allowed to stand for thirty to fifty minutes exposed to the air in the laboratory, or (since this often failed in introducing organisms) had a drop of water from the tap added to it; the fourth was simply opened under spray, touched with a pure rod, and again covered.

Each series of four was kept together, and the result of exposure to various temperatures noted. The temperatures employed seemed to make little difference to the result; and, after this had been discovered, they were all kept in the incubator at a temperature of 98° Fahr.

When opened, after a month to six weeks, the following results were always obtained. The first flask (micrococcus) was limpid, odourless, acid or neutral, and seemed unaltered in any way. Its upper strata contained no organisms; but in its deeper strata, and in the thin film of sediment, micrococci were found growing and moving. Their growth was, however, by no means abundant or satisfactory; and, like those from wounds, they repeatedly failed to produce any effect when injected into animals. The second flask (bacterium and bacillus) was turbid, stinking, alkaline, and gave off ammonia. Its surface presented sheets or turfs of actively moving rods and bacteria. Its lower strata contained these organisms motionless, apparently dead. The third flask (water) was like the second in every way, save that micrococci were often found in its deeper strata. The fourth flask was unaltered in any way, and contained no organisms.

Repetitions of these trials yielding always the same results, it occurred to me that, as the cocci were found only in the strata removed from the influence of the atmosphere, they might possibly be organisms capable of living without air—anaerobes, as Pasteur (*Bulletin de l'Académie de Médecine*, 1878, No. 18) styles such. Their cultivation was, therefore, once more attempted in the first mentioned cells, and in the same fluids as before; the cells being filled with carbonic acid gas instead of air. But, whether from the carbonic acid escaping by diffusion, or from some other cause of which I am not aware, no better success was obtained than in the earliest set of experiments.

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 water; and, under spray, a minute aperture was pierced in the larger end. One minim of pus from an acute abscess, collected under the strictest antiseptic precautions, was injected by a long pointed pure syringe into the albumen at the opposite end of the egg. A piece of protective was laid over the aperture. The egg was enveloped in a Lister's dressing, and kept for ten days in the incubator at 98° Fahr. At the end of that time, it was opened, and my expectations were fulfilled. The egg was sweet and fresh; its contents were unaltered, 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 coccus 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 abscess, 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 experiment, by injecting a drop of albumen from a fresh egg into another part of the same animal, gave the result to be expected, in a complete disappearance of the injection, without leaving any trace. This experiment 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

* Antiseptic precautions are always understood, save where the reverse is specially mentioned.

the two eggs had been grown for six weeks in urine in the doubly covered glass bottle. An acute abscess, with its usual accompaniments, resulted in all these instances. Thus the cocci, diluted so that (assuming an egg to contain thirteen fluid drachms) only 1:146,016,000th of a drop of the original pus could have been injected, produced an abscess—a result inexplicable save on the assumption that they were the sole cause. The former observations on the growth, development, and movements of the micrococci in pus were repeated, and controlled by those contained in the egg-albumen.

Experiments on eggs by the introduction of pus containing other forms of organisms, such as bacteria and bacilli, showed that these latter also grew under such circumstances, but produced extreme putrefaction in the eggs, and blackened their red portion.

The behaviour of micrococci in wounds and ulcers was now explained. They grow badly where exposed to the action of the air, and in this imperfect condition do not reproduce themselves with the rapidity necessary for the exhibition of their noxious influences. They probably also lose for a time, when grown under such circumstances, a considerable portion of their activity and virulence. When placed in more favourable conditions, as when removed from the exposed urine to the sheltered egg, they speedily reacquire their ancient powers of inducing disease. This seems also to explain their being so prone to cause blood-poisoning in deep and sinuous wounds, as in those produced by a compound dislocation or removal of the thyroid gland.

To sum up: Micrococci do not produce putrefaction. They develop best when removed from the atmosphere. The preceding facts prove that they are able, under suitable conditions, to give rise to blood-poisoning, to acute inflammation, and to suppuration.

V.—CONCLUSION.

Little remains to be added under this head. The more these things are reflected on, the more pregnant they become with explanations and suggestions regarding many of the obscure facts in connection with the processes of inflammation and blood-poisoning. They tend to confirm the supposition of Kocher, that acute inflammations are due to micro-organisms; they suggest many probable hypotheses to explain the difficulties occurring in the study of pyæmia, septicæmia, gonorrhœal rheumatism, etc.; the different virulence of gonorrhœal balanitis and gonorrhœal urethritis; the occurrence of mammary abscess and pelvic suppurations after childbed; the causes and varieties of dissection and poisoned wounds; the success attending the open-air treatment of wounds; the causes of surgical fever; and many other features of disease that it would be premature to discuss here.

It is not intended to be conveyed by anything that has been said, that micrococcus is the only organism which produces such results: the other organisms fall to be investigated in their turn, and much yet remains to be done, for the subject is only in its infancy.

I cannot close this paper without expressing my thanks to Professor Ewart and Dr. Walker of Aberdeen, for their counsel and assistance, and my sincere sense of the obligations I am under to the Committee of Scientific Grants, and through them to the British Medical Association, for the aid they have generously given me, without which aid I had previously found it impossible to grapple with the subject of micro-organisms in surgical diseases, save in a most imperfect way.

TRUE AND FALSE DYSPEPSIA.—In a communication made to the Paris Academy of Medicine on January 11th, M. G. Sée set forth his views on the diagnosis of true and false dyspepsia. After having noted that a dyspepsia is a true one when the digestion undergoes a permanent chemical disturbance, he asserted that a number of invalids show the same apparent phenomena as dyspeptics, without experiencing the unpleasant effects or the serious results of chronic dyspepsia. The morbid conditions designated pseudo-dyspepsia by M. Sée, which assume the forms of dyspepsia, are localised in three organs—the intestines, the liver, or the stomach itself. These conditions comprise five types, which were successively passed in review by the writer—viz., simple atony of the intestine with habitual constipation and permanent tympanic distension; atony of hæmorrhoidal or of mechanical origin; atony followed by muco-membranous enteritis; asthenic condition of the intestine, due to diminution of the biliary secretion; spasmodic atony of the stomach. M. Sée described, as a fifth type of pseudo-dyspepsia, spasmodic atony of the stomach, better known under the name of gastralgia or gastric neuralgia. He held that gastralgia has no connection with neuralgia, neurosis, nor hyperæsthesia; it is an additional motor disturbance, and not one of sensibility. After having sketched out the diagnosis of spasmodic atony and dyspepsia, M. Sée ended his communication by the conclusion that the atonic patient suffers constantly and digests well; whilst the victim of dyspepsia digests badly and suffers frequently.

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 Disease in the Local Bills promoted this Session by the Sanitary Authorities of Aberdeen, Barrow-in-Furness, Birkenhead, Bradford, Reading, Salford, and Stalybridge.—Need for Caution in granting Exceptional Powers as to Domestic Quarantine of Infectious Disease.—Notification of Infectious Cases.—Regulations as to Infected Persons, Places, and Things.—Provision of Hospitals, and Compulsory Removal thereto.—Disinfection of Premises, etc.—By-Laws.—Height of Rooms.—Unnecessary Clauses in Local Bills.—Effect of Local Changes in General Statute Law.—Suggestion for Conference with President of Local Government Board.

Provisions as to Infectious Disease in Local Bills of this Session.

In a report bearing the same title as the present, which I presented to the Parliamentary Bills Committee on the 2nd of February, 1886, I undertook to criticise, from a medical and sanitary view-point, certain proposals 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 a number 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 towns 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 I make, 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, Salford, 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, enteric 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 sixpence; 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 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 nurses for attendance upon persons suffering from infectious disease (and to charge any reasonable sum for any nurse so provided); (D) to order public or private day-schools, or other places of public resort situate in neighbourhoods 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, clothing, or other articles liable to retain infection, to be temporarily closed, whenever, from the appearance of infectious disease in such shop, dairy, or other place, or in rooms in connec-

^{*} 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.