entered the house. A case of typhoid fever had recently occurred on the premises. I expressed a decided opinion that a drain poison was the cause of the renal disease, and advised that the condition of the drainage should be thoroughly investigated.

I have since learnt from the gentleman whom I met in consultation, and from the patient's wife, that after my visit the drainage was examined, with the following result. Peppermint water having been poured into the upstairs closet was at once detected by its odour in the hall; and beneath the hall floor there was found a defective joint in the soil pipe from the closet, so that sewage had escaped into the earth upon which the floor of the hall rested. The sitting room, which was generally occupied by the patient and his wife—they have no children—opened into the small hall. Here then is the explanation of the "earthy smell" which had often been noticed; and I have no doubt that the chronic diarrhoea and the albuminuria were directly due to the same cause. The fact that the health of the patient's wife, who had been even more continuously exposed to the same poison, had not apparently suffered, is quite consistent with this explanation of the husband's illness. We have frequent opportunities of observing that out of a number of persons exposed to the same morbid agency, only a small proportion become seriously ill. Additional evidence that the diarrhoea was excited by the sewer poison is afforded by the fact that this symptom, which had continued until the time of my visit, and for some days afterwards, ceased almost immediately after he left home to stay with a friend for five weeks. The defective drainage was made good during his absence, and during the fortnight since his return home there has been no return of the diarrhoea. His general condition, too, is reported to have improved, and the albumen has diminished by one-third.

CASE IV.—Miss B., aged 35, had been more or less ill since she had undertaken the management of a country hotel six months before I saw her. During the last six weeks the urine, which had not before been examined, was found to be blood-tinged. At the time of my visit the urine was brightly blood-tinged, specific gravity 1012, contained albumen (8 grammes per litre), and deposited granular and hyaline casts and oily cells. The secretion was very scanty. The patient was very pallid and feeble; there was frequent vomiting; temperature 102°; much dyspnoea, with a rapid and feeble pulse. The prognosis was most unfavourable. When I saw her a second time three days later, the symptoms were worse; there was almost complete suppression of urine, and she died on the following day.

This lady was in good health when she took up her residence in the hotel. The drainage was found to be bad, and the drains were opened and repaired while she remained in the house. I have no doubt that the illness, which commenced soon after, and which culminated in fatal degeneration of the kidney, was the result of drain poisoning.

The medical attendant who sent me the account of the defective drainage which was discovered in connection with Case 3, ended his report by saying: "I very much doubt whether the profession at large is sufficiently alive to this subtle cause of albuminuria."

It is hoped that the publication of these illustrative cases may serve to direct more general attention to this frequent, though often unsuspected, source of renal disease.

In connection with this subject, it is not without interest to remark that amongst the numerous diseases which may result from defective drainage and consequent sewage poisoning, diphtheria is, in a very large proportion of cases, associated with albuminuria, a fact which Dr. Wade was the first to make known.

The history of such cases as have been here briefly recorded serves to illustrate a principle which cannot be too much insisted upon, namely, that the treatment of symptoms by drugs forms but a small part of the art of healing, and that one of the main objects of rational medicine is to trace disease to its cause. What a melancholy exhibition of unscientific impotence is the attempt to arrest by opiates and other astringents a diarrhoea, the result of perpetually inhaling a septic drain poison!

It can scarcely be doubted that the diarrhoea and the albuminuria having such an origin are the result of a physiological effort by the bowel and the kidney to eject the poison and its noxious products from the system; and it is obvious that an essential condition of successful treatment in such cases is the discovery and removal, or avoidance, of the exciting cause of the symptoms.

ST. THOMAS'S HOSPITAL was visited by the Queen of Sweden on Tuesday last.

LECTURES

ON

SUPPURATION AND SEPTIC DISEASES.

Delivered at the Royal College of Surgeons, February, 1888.

By W. WATSON CHEYNE, F.R.C.S.

Hunterian Professor; Surgeon to King's College Hospital, and to the Paddington Green Children's Hospital; Examiner in Surgery at the University of Edinburgh.

LECTURE II.

WE have thus found that these pyogenic cocci are constantly present in suppurative affections; that they can cause suppuration both in animals and in man, as evidenced by experiments, and also by the microscopical observation of the changes which occur at the seat of infection; and, further, that true acute suppuration does not occur naturally when these organisms are absent. It would therefore appear as if, with the discovery of the pyogenic organisms, the etiology of acute suppurative affections was satisfactorily settled. This, however, is hardly the case, for the following considerations, among others, render it evident that in most cases other factors in addition to the micro-organisms must come into play. Thus we find a great variety of morbid processes caused by the same organisms. The staphylococcus pyogenes aureus can set up a superficial inflammation of the skin, a boil, an abscess, acute ulcerative endocarditis, or even pyæmia; and the streptococcus pyogenes causes sometimes phlegmonous inflammation, sometimes peritonitis, sometimes puerperal fever, and sometimes pyæmia. Then, again, we have the fact, on which I have not as yet dwelt, that, in order to produce these suppurative affections in animals, various conditions, such as the injection of large numbers of the micro-organisms, are essential.

That these organisms are not of themselves able in most cases to set up these suppurative diseases is evident also from the fact that they are frequently present in the blood without producing any suppurative affections. Thus Ogston states that in cases of septicæmia in man the micrococci are present in the blood, and are excreted in a living state in the urine, and he makes no mention of the occurrence of secondary abscesses. Ogston's statement has been confirmed by von Eiselsberg, who examined the blood of almost all cases in Billroth's *clinique* who were suffering from septic fever, and was able to demonstrate the presence of staphylococci and streptococci, most frequently of staphylococcus pyogenes albus, in the blood; and yet apparently no abscesses formed. In the case of acute osteo-myelitis also Garré has found the pyogenic staphylococci in the blood, although the patients did not suffer from abscesses in more than one situation. In connection with acute osteo-myelitis, perhaps the most interesting observations as showing that these organisms may exist in the blood without doing any harm are those in which children have been born suffering from this disease while the mothers, through whose blood only the organisms could have come, have apparently been in good health. As an example of this I may mention a case published by Rosenbach in a paper on acute osteo-myelitis.

E. A., aged 30, was delivered of her fifth child in June, 1858; she had been married ten years, and all her other children were living and healthy when born; she was not aware of having suffered any fright or injury to account for the disease in the child's leg. The latter, a full-grown boy, was born dead at full time, and had apparently been alive quite recently. Attention was at once drawn to the right leg, which was swollen and showed distinct fluctuation both in front and behind. Immediately below the patella there was a bulla on the skin; the whole leg had a marked erysipelatous character, and on making an incision a large quantity of pus was evacuated, and it was then found that the greater portion of the soft parts of the leg was destroyed, and that there was scarcely any muscular substance to be seen. Further investigation showed that almost the whole of the periosteum of the tibia was detached and the bone was in a state of necrosis. At the lower part a small portion of the periosteum was inflamed, but still adhering to the bone; at the upper part the epiphysis of the tibia was almost entirely separated from the

shaft, and was only connected with it by a few membranous threads.

Then we have a very interesting paper by Escherich on the presence of pyogenic cocci in the milk of women suffering from puerperal fever. In a considerable number of these cases he demonstrated the presence of the same pyogenic cocci in the milk from both breasts, and in these cases there was every reason to believe that the organisms had reached the milk from the blood; more especially there was an entire absence of any disease or ulceration of the nipple; and yet in these cases there were apparently no abscesses either in the mamma or elsewhere. Escherich's observations have been confirmed by Longard, and both of these investigators have made experiments on animals which had just brought forth young, which show that very shortly after the injection of these organisms into the blood they appear in the milk.

These pyogenic cocci have also been found in the blood in various febrile diseases, and not necessarily in association with suppuration. Thus, in scarlet fever Loeffler found the streptococcus pyogenes, or an organism indistinguishable from it, in the diphtheritic membrane in cases of scarlatinal sore-throat, and he observed that in some cases these organisms penetrated from the surface into the body. Fränkel and Freudenberg have also investigated the organisms of scarlet fever, and have found that the streptococcus pyogenes is present in the blood in a considerable number of cases, without, however, apparently giving rise to any suppurative or septic affections.

I need not go into further details to show that these micro-organisms do not necessarily of themselves set up suppuration and septic diseases when present in the body; in the following considerations sufficient evidence of this will be brought forward.

CONDITIONS NECESSARY FOR INFECTION.

The conditions which are necessary to enable these organisms to live and act in the body may be considered according as they chiefly affect the body, or according as they chiefly affect the microbe. We have also some conditions—such as temperature, season of the year, locality, moisture, etc.—which must be grouped under a third heading; for, with regard to these, we do not know whether their influence is due to some action which they exert on the body, or to some effect which they produce on the microbe. In considering these conditions, it is not possible to draw a sharp line between the various groups, because a number of these conditions are almost always combined in the same case; but I shall, as far as I can, endeavour to avoid repetition, and at the same time to treat of the various facts under their chief headings.

Had time permitted, I should have liked, before entering on the consideration of these conditions, to have traced the fate of the pyogenic organisms in the body when they fail to get the upper hand. And we should have found that these organisms disappear in a very remarkable manner from the blood; that they are, in fact, apparently rapidly killed in the blood, or deposited from it in various tissues and organs, or possibly excreted through the various excretory glands. The rapidity with which some organisms disappear from the blood is very remarkable; it is in many cases a matter merely of minutes, certainly of an hour or two; and this disappearance of the organisms from the blood must be due to an active destructive action of the constituents of the blood on them; mere unsuitability of soil is not sufficient to account for the rapidity of the phenomenon. We should also have seen that there is good reason for believing that these organisms may be excreted by the various excretory glands, although this is a matter about which there is still considerable dispute. That they are so excreted by the kidneys is shown by various observations; and this is an important point to remember, as probably explaining certain cases of pyelitis occurring in patients who have never had any instrument passed, and whose urethra and bladders are perfectly normal, the occurrence of these cases being explained on the supposition that the organisms had entered the blood in a living state, were excreted by the kidneys, and afterwards, as in the example of which I showed a drawing at last lecture, found a suitable pabulum in the urine and grew in the pelvis of the kidney. As regards excretion from the mamma, I have referred to the observations and experiments made by Escherich and Longard; and these facts are of interest in connection with mammary abscess, as showing that the organisms which set up these abscesses may arrive at the gland from the blood, and either grow in the tissues or in the acini of the gland after excretion; although without doubt the great majority of abscesses of the mamma are

caused by the spread of the organisms inwards, either along the milk-ducts or from cracks in the nipple. We should also have seen reason to believe that the salivary glands, more especially the parotid, occasionally take part in this excretion of pyogenic organisms, thus again offering a possible explanation of the not infrequent occurrence of abscesses in the parotid gland after suppuration elsewhere.

The study also of the exact mode in which the body carries on the battle with the microbes, more especially the study of the investigations which have been set on foot as the result of Metschnikoff's experiments on phagocytosis, would have furnished us with much interesting and suggestive material for consideration, and we should have seen what an important part the leucocytes play in the destruction of micro-organisms and in the limitation of inflammatory affections, although the evidence does not as yet seem to be sufficient to support Metschnikoff's idea that these cells act by taking up the organisms into their interior, and there killing them.

I must, however, omit the consideration of these matters, and pass on to the discussion of the conditions which enable or hinder these organisms to act; and the first condition, and an essential one, which we have to notice, is that an opportunity must be afforded to the organisms of resting for a time in the part in which they exert their action. If they are floating in the blood current they must be arrested at some part, and not only must they be arrested, but, as we shall see, they must find, at that spot, conditions suitable for their growth.

Embolism.—Such mechanical conditions, causing the arrest of organisms, are brought about by embolism, thrombosis, injury, etc. The importance of arrest of organisms has been beautifully shown by Ribbert in some experiments which he performed with a pathogenic species of mucus. When the spores of pathogenic aspergilli are injected into the blood, deposits are formed in various organs, and also in large numbers in the various muscles. In the case of mucus, however, Ribbert noticed that while the spores, when injected into the blood stream, gave rise to deposits in various organs, the muscles remained only slightly or not at all affected. On looking into the matter, it was seen that the spores of mucus were very small, much smaller than those of aspergillus; and Ribbert thought it possible that the reason why masses occurred in the muscles in the latter case and not in the former, was that, on account of the larger size of the aspergillus spores, they were caught in the capillaries of the muscles, while the mucus spores passed through them. He therefore sought to increase the size of the mucus spores before their injection into the blood, and this he did by keeping them for a short time in a nutrient fluid, at the temperature of the body. As a consequence, the spores swelled up and commenced to sprout, and when he found, under the microscope, that this had occurred, he injected the material into the circulation. The result corresponded entirely to his expectations; in contrast to the control experiments, he found that in these cases fairly numerous deposits of fungi were present not only in the organs but also in the muscles of the back and extremities.

Referring, however, more especially to experiments with the pyogenic organisms, we have several facts of a similar nature with regard to their action on rabbits. The injection of moderate quantities of staphylococcus pyogenes aureus into the circulation of rabbits is followed, as a rule, only by abscesses in the kidneys, the other organs apparently remaining unaffected; but a number of experiments which have been made, among others by Ribbert, on the production of myo- and endocarditis in these animals, have shown that abscesses can be set up in other organs if the pyogenic cocci are attached to gross particles, which cannot pass the capillaries of these organs. Thus, Ribbert was able to produce myocarditis by using a cultivation of staphylococcus pyogenes aureus on potatoes if he took care, in removing the cultivation from the surface of the potato, to scrape off also the superficial layer of the potato itself. If this mixture of potato granules and organisms was rubbed up with water, so as to form a fine emulsion, and then injected into the circulation, the result was the production of deposits of organisms in the muscular tissue of the heart, as well as in other organs, leading to myocarditis; if the particles of potato were very fine, only myocarditis resulted, but if they were coarser, endocarditis occurred as well.

Bonomé investigated nine cases of gangrene of the lungs in man, and found in three of them staphylococcus pyogenes aureus alone, in five staphylococcus pyogenes albus alone, and in one both organisms together. He tried to set up gangrene of the

lungs in rabbits by the injection of these organisms into the circulation, but he failed to do so if only the cultivations of these organisms were employed. He succeeded, however, by taking pieces of the pith of the elder tree, breaking them up into very fine fragments, mixing these fragments with the cultivation of the pyogenic organisms, and then injecting this mixture into the jugular vein. The result was numerous deposits of cocci in the lungs, leading, as shown in the last lecture, to extensive conglutination necrosis of large tracts of these organs, and, as a consequence, to extensive gangrene. Injection of the fragments of pith alone caused no effect.

In the same way Rujis found that if he injected a small quantity of a fluid cultivation of staphylococcus pyogenes aureus into the uninjured eyes of rabbits suppuration did not result, and he concluded that the reason was that the cocci were carried away too quickly by the lymph stream; for if he soaked sterilised cotton threads in the cultivations, and then introduced portions of these threads into the anterior chamber of the eye, suppurative panophthalmitis occurred.

The last experiment that I shall mention is one by Pawlowsky, who found that, by the simultaneous injection of sterilised cinabar, and of cultivations of staphylococcus pyogenes aureus into the circulation, he produced abscesses in various organs—in fact, the typical picture of pyæmia.

The great importance of these facts in explanation of the etiology of pyæmia will be at once evident. Whether cases of pyæmia occur in man, like those described by Koeh in the case of rabbits, as the result of the growth of cocci in the blood, their entanglement of blood-corpuscles, and the consequent formation of emboli, we do not know; but it is very doubtful if this takes place, for the same cocci which seem to be the cause of pyæmia may, as we have said before, be often present in the blood in considerable numbers without causing abscess or embolism. It is easy, however, to understand that the ordinary pyogenic cocci may cause pyæmia if they enter the blood attached to portions of blood-clot, or other solid material. This, in fact, is evident from the experiments mentioned, and thus the importance of thrombosis and embolism as factors in the production of pyæmia is clearly established. These emboli are not always necessarily emboli composed of detached portions of blood-clot; in some cases, probably, especially where the streptococcus pyogenes is the active agent, the organisms grow in the lymphatic vessels, and the emboli are formed there and arrive at the blood with the lymph stream. Probably in pyæmia other factors also come into play, such as large dose of the organisms, general depression of vitality, possibly also greater virulence of the organism; but it is evident from these considerations, and from the clinical and pathological facts, that embolism must play an important part. Pyæmia must thus be clearly distinguished from multiple abscesses, the so-called chronic pyæmia, where embolism does not probably play any part but where the cocci are able to circulate in the blood and are deposited in some part weakened by injury or other depressing cause.

The mere arrest of these pyogenic organisms in the circulation, although an important factor, is not, however, as a rule sufficient of itself to lead to the production of disease. This is very well seen in the case of rabbits. Inject a considerable number of pyogenic cocci into the circulation of a rabbit, and kill it within twenty-four hours, it will be found that masses of organisms are present in the capillaries of the lungs and other organs of the body; but allow such an animal to live for forty-eight or seventy-two hours, and it will be seen, on killing it, that the organisms have disappeared from the various organs, with the exception of the kidneys (Ribbert). Here we have evidence that, although the organisms had been able to stick in the various organs, the other conditions were not favourable for their growth and action; and in the case of embolism it is probable that the material to which the cocci are attached of itself aids their growth by causing injury to the endothelium of the blood-vessels, and thus leading to the production of a weak spot: in the case of emboli composed of blood-clot the emboli are saturated with the products of the cocci, and are thus still more likely to injure the part. We must therefore pass on to the consideration of other conditions which aid the action of these organisms, and the chief of these is what we may vaguely term general and local depression of vitality.

General and Local Depression of Vitality.—That general depression of vitality can enable these organisms to live in the blood for a considerable time has been shown by a number of experiments. For example, I found, in experiments on the presence or

absence of organisms in the living tissues, that while organisms were absent when the animal was in a good state of health, yet if the vitality of the animal was depressed—say, by administering large doses of phosphorus for some time—organisms could be found at times in the blood and tissues of the body. The same conclusion must be drawn from the following experiment. If of a putrefying fluid not containing pathogenic organisms, varying quantities are injected into the circulation of animals, it will generally be found that after twenty-four hours the organisms have entirely died out in those animals which received a small dose, while in those in which a larger quantity—say, 1 cubic centimetre—was injected, in other words, in those whose vitality was depressed by the introduction, at the same time, of a quantity of the poisonous chemical products of these bacteria, organisms may still be found alive. This is a fact which has been confirmed by a number of observers; but as I shall have again to refer to experiments from which similar conclusions may be drawn, I shall pass on to what is much more important for the matter under discussion, namely, the result of local depression of vitality.

A number of experiments show that when the vitality of a part has been lowered by cutting off the blood-current for a comparatively short time, organisms grow in that part much more readily and luxuriantly than if the blood stream had not been interfered with. To mention one or two examples: according to Cornil, a septic nephritis is readily obtained by ligaturing the renal arteries for some hours, and then, after removal of the ligature, injecting pyogenic organisms into the blood.—Heubner's experiments on the artificial production of diphtheria also show, in a very marked manner, the effect of local depression of vitality as the result of cutting off the blood stream temporarily. Heubner arrested the circulation in the fundus of the bladder for two hours by the application of a ligature to the vesical arteries. After removal of the ligature there resulted intense congestion and oedema of the submucous tissue, while, at the same time, as the consequence of the temporary inanition, the epithelial cells died; after the circulation was again restored, there was a great exudation of blood plasma and cells, in fact, coagulation necrosis occurred on the mucous surface. Heubner found that if, at the same time that the circulation was restored, septic bacteria were injected into the blood, they accumulated in large numbers in the affected part of the mucous membrane of the bladder, and set up extensive disease.—In order to obtain these results, it is, however, necessary that large numbers of bacteria should be present in the blood, and this factor can only very rarely come into play in Nature, where the number of bacteria is seldom sufficiently great. Thus, in the case of strangulated hernia, even where the circulation has been arrested for a considerable time, comparatively little harm is done, and unless actual gangrene of the bowel wall has occurred, bacteria are very seldom found in the fluid contained in the sac of the hernia, nor does bacteric peritonitis occur.

In conclusion, I may mention an experiment of Cornil's, who states that if a slight nephritis is set up, either by cantharides or in some other way, and if then pyogenic organisms are injected into the blood, a septic nephritis occurs. This last experiment leads us to the consideration of a very important factor in the production of local depression of vitality—namely, inflammation.

Inflammation.—Inflammation is frequently looked on as a predisposing cause of these suppurative diseases, and it has been held that inflammation leads to the formation of a weak spot where bacteria can settle and develop; and that, while inflammation can be set up by other causes than micro-organisms, the pyogenic cocci are very apt to become added to it, and then suppuration results. On the other hand, in old times, when wounds were allowed to become septic, it was generally held that the patient was safer when the surface of the wound had become covered with granulations than before granulation had taken place. We have also seen, in considering the anatomy of abscess, that as the granulation tissue increased in amount, so the penetration of the organisms into the body was rendered more difficult, and they remained more and more limited to the interior of the abscess. In the case of erysipelas, the cessation of the inflammation seems to stand in some relation to the accumulation of leucocytes in the part. In the case of tubercles, also, which consist of a central mass of epithelioid cells and an outer wall of leucocytes, I believe that the external circle is purely an inflammatory circle, and is of great importance in limiting the spread of the tubercle bacilli. That preliminary inflammation is not essential to enable the pyogenic organisms to act is shown by many facts, such as Garré's and Bockhardt's experiments on themselves, and similar experi-

ments performed by Grawitz with reference to acne contagiosa of horses, where the organisms which are the cause of the disease produced it when rubbed into the skin.

To explain the facts of the case, I must shortly recall the chief points as regards inflammation. Inflammation which has gone on for some time may be divided into three stages. In the first stage we have the preliminary dilatation (or it may be, in some rare cases, contraction) of the vessels, the increased flow of blood through the part and along with this, increased flow of lymph, soon followed by slowing of the circulation, and ultimately by inflammatory stasis, with, at the same time, exudation of blood plasma and corpuscles. In the second stage the irritation is continued, and the tissue originally attacked by the inflammation is removed and its place taken by granulation tissue. In the third stage the irritation has ceased, and retrogressive changes occur, leading to the formation of a scar.

If we consider the state of the tissues in these three stages we see that in the first stage, as was long ago pointed out by Sir Joseph Lister, the vital activity of the tissue is suspended, the functions of the tissues are, so to speak, paralysed; in other words, the tissue has become an extremely weak tissue, and one unable to resist in any way the entrance of the parasites. In the second stage this weak tissue has been removed, and its place has been taken by young, vigorous, healthy granulation tissue, which has probably great power in repelling the attacks of the organisms. Lastly, in the third stage this granulation tissue is getting older, and becoming converted into less active tissue. The first stage of inflammation is partly defensive and partly reparative, and always occurs after every injury. The second stage may be looked on as a purely defensive stage, the irritant still continuing to act. In the third stage the irritant has gone, and processes leading to permanent repair take place. The relation of inflammation to infection may perhaps be best illustrated by regarding it as an instance of instinctive action. The first effect of the irritant is to damage the part, and the first result is dilatation of the blood-vessels and increased flow of blood and lymph; the part, in fact, is flushed with blood, as if an attempt were being made to wash away the irritating cause (Landerer). This is a process which is probably constantly occurring in our bodies with satisfactory results. If the irritant continues to act it is very soon found that these attempts are ineffectual, and the next instinctive method of protection is to get rid of the injured tissues and to supply their place by young, strong, healthy tissue—granulation tissue. Finally, when the irritating cause has been got rid of, the vigilance of the part is, so to speak, relaxed, and the tissues proceed to develop into a less active and less vigorous tissue, namely, fibrous tissue.

Clinically, the organisms enter during the first and last stages, more especially during the first, and not, as a rule, during the intermediate stage, unless, indeed, while growing outside the new tissue, on the surface of the wound, they can so injure it as to reduce it again to the position of a weak tissue—to the first stage, in fact. This is very well shown in a series of experiments made by Huber on the localisation of virus. Huber performed his experiments on rabbits, and set up inflammation in one ear by rubbing in croton oil, the other ear being left intact for purposes of control; the infective material employed was virulent anthrax bacilli, and these were introduced into the body as far as possible from the seat of inflammation, namely, at the root of the tail. According to the stage of inflammation which he desired to study, Huber applied the croton oil before or after the infection with anthrax bacilli. The result of these experiments was, in the first place, that the bacilli were not found outside the vessels in the tissues of the inflamed part in any stage of the inflammation; and, in the second place, that their presence inside the vessels was dependent on the stage of the local affection. Thus in the first stage, where there was inflammatory oedema, this stage reaching its height in about seven hours and a half, there was a very marked increase in the number of the bacilli in the capillaries of the inflamed part, as compared with the number which were present in a similar part of the opposite ear. As the inflammation passed into the second stage, the number of bacilli in the capillaries of the inflamed part gradually diminished, till, when this stage was at its height—after forty-eight hours—the bacilli had completely disappeared, although they were present in large numbers in the capillaries of the other ear. During the third stage, where the inflammation had subsided, and where new tissue was being formed, bacilli again appeared, and were found in considerable numbers in the newly-formed vessels. Ultimately, when the

scar had been formed, there was no difference as regards the number of bacilli in the capillaries of the scar and the number in the capillaries elsewhere.

It has been found, as regards the pyogenic cocci, that if they are circulating in the blood, the induction of a severe inflammatory action does not lead to their deposit in the part, while if the inflammation is less severe, they can apparently pass out of the blood-vessels and set up suppuration. Thus, Rinne concluded from his experiments on suppuration that a violent inflammatory action did not produce a *locus minoris resistentie*, but that the slighter injury caused by the chemical products of the bacteria themselves sufficiently weakened the part to enable the organisms to grow in it.

Acute osteo-myelitis and local tubercular diseases frequently stand in some relation to injury, but they are not, as a rule, attributed to severe injuries, but usually to some slight blow or sprain. In a phthisical individual fracture of a bone or some other severe injury is not followed by the development of a local tuberculosis, whereas a slight sprain is very commonly mentioned as the exciting cause of such a process, the probability being that the severe injury sets up too great reaction to enable the organisms to act, while the slighter injury simply weakens the heart.

Cold.—Another point which has been much discussed, in relation to inflammation and suppuration, is the effect of cold. It is generally assumed that cold is a frequent cause, or at least a very predisposing cause, of inflammation, as, for example, in the production of pneumonia. That cold may play an important part as one of the factors in that disease is very probable, but it is needless for me to say that we are constantly subjected to violent changes of temperature without the production of inflammatory disease, so that it seems as if when a result is obtained some other factor comes into play.

That cold can cause inflammatory affections where the conditions are suitable is evident as regards the external surface of the body from the production of chilblains, the tissue thus weakened being brought into a condition rendering it very liable to attack from organisms.

As regards the effects of cold on the internal parts of the body, some very interesting observations have been made by Lassar. A number of rabbits were shaved, or deprived of their hair in some way or other. These animals, when kept at a suitable and equable temperature (about 20° C.) and well fed, remained in good health. But on being taken out of the warm room and plunged into ice-cold water for from one to three minutes, then dried carefully, chafed, and warmed again, they almost always, in the course of one or two days, showed albuminuria, increasing at a later period, often to a great extent, and accompanied by the presence of hyaline cylinders in the urine; at the same time, the rectal temperature was as much as 1.5° C. above the normal. These animals often recovered from the albuminuria, but were again similarly affected when again exposed to cold. On microscopical examination of the organs, they were seen to be in what Lassar terms a state of "interstitial inflammation;" the organs chiefly affected being the kidneys and liver, but also in some cases the lungs, muscular tissue of the heart, and the sheaths of the nerves. In the organs it was seen that there was no degeneration of the interstitial tissues, but the blood-vessels, especially in the lungs and liver, were often enormously dilated, the arteries filled with thrombi, and large numbers of leucocytes in the tissues in the neighbourhood of the veins. The effect of cold in these experiments seems, in fact, to be the production of what is probably a weak tissue, and one therefore liable to attack from organisms.

As to the relation of pyogenic organisms to animals acted on by cold, I only know of experiments by Grawitz on the relation of peritonitis to cold, but his experiments are not sufficiently satisfactory. He shaved the skin of the abdomen in young animals, covered it for from half to one hour with warm compresses, and then, suddenly removing these, allowed a draught of ice-cold air to play on the part for twenty to forty minutes. This caused no bad effect on the peritoneum, nor was any bad result produced on that membrane when organisms were simultaneously injected into the intestinal canal or into the blood; and in one experiment the cocci were injected directly into the abdominal cavity, also without setting up peritonitis. In the last experiment, however, the cocci were injected three-quarters of an hour before the commencement of the exposure to cold; and it is highly probable that, under the circumstances, they had died or had been removed by the healthy peritoneum before the application of the cold, and this is the more likely to have been the case seeing that the

activity of the peritoneum was probably increased as the result of the warm compresses applied to the skin over the abdomen.

Injury.—An important cause predisposing to the occurrence of suppuration is injury, which probably acts in two ways; in the first place by setting up the early stage of inflammation, and in the second place by leading to effusion of blood, and thus enabling any pyogenic cocci which may be circulating in the blood to pass out of the vessels, and find in the cellular tissue a suitable place for their development.

The effect of injury is well shown in experiments which have been made on the production of acute endocarditis. In order to induce this disease in animals by injection of the pyogenic cocci into the blood, it has been found either that the number of cocci employed must be very large, or that they must be attached to gross particles, as has already been mentioned, or that some injury must be caused to the valves before their injection. Wyssokowitsch and others have performed experiments of this kind, and have found that, by introducing a rod into the jugular vein, they were able to cause laceration of the valves, and that then, on subsequent injection of staphylococci into the blood ulcerative endocarditis occurred. The effect of the injury in this instance is no doubt chiefly to lead to loss of resisting power in the endothelial and connective tissue cells, as the result of the early stage of inflammation induced by it.

The relation of injury to certain inflammatory diseases in man is generally accepted, and I need only instance the case of acute osteo-myelitis, which is frequently attributed to an injury. In experiments on animals, on the production of acute osteo-myelitis, it is, as a rule, necessary not only to inject the pyogenic organisms into the blood, but also to cause some injury to the bone. If this is done, especially where large numbers of cocci are introduced into the circulation, the animals generally die in from twelve to fourteen days, much emaciated, and showing pus at the seat of fracture, pus in the medulla, and necrosis of bone. With regard to man there are several cases on record in which the relation of injury to this disease is very strikingly shown, and the fact that the disease occurs much more often in males than females, and especially in young males, is usually attributed to the fact that injuries are sustained more frequently by boys than girls. At the same time, the number of cases of acute osteo-myelitis in man, in which the direct relation to an injury can be satisfactorily traced is, in reality, comparatively small; and that injury, though it plays a part in some instances, is not an essential condition for the production of the disease is shown by its occurrence after acute fevers, and also by the fact that it is limited, as a rule, to certain favourite seats. When, however, the disease affects bones, or parts of bones, which are not usually attacked, a history of injury or cold can generally be obtained to explain its occurrence in these abnormal situations.—In the case of wounds also we must not forget that the injury done to the surface of a wound during an operation by the knife and the manipulations sets up the early stage of inflammation, and that thus the surface of a wound is, for a few hours at any rate, a weak surface, and unable to resist attacks from organisms.

That one great explanation of the value of injury in aiding the occurrence of suppurative diseases is the extravasation of blood from the vessels is shown in a very striking manner by experiments on symptomatic anthrax, a disease to which I shall have to allude in detail presently. I may say here that this disease is caused by bacilli, but is not set up if the bacilli are introduced into the circulating blood; in order to produce it the bacilli must act in the cellular tissue. After injection of the organisms into the blood the animals remain well, and the bacilli very soon disappear; if, however, shortly after the injection of bacilli into the blood, a bruise is produced in some part of the body, the bacilli pass out of the vessels into the cellular tissue along with the blood, grow there, and soon cause the formation of the characteristic tumours, the spread of the disease, and its fatal termination.—In man it is sometimes seen that bruises in weakly individuals are followed by suppuration, and I have already published the case of a drunkard who had albuminuria, and was in a very low state of health, and who, whenever he received a bruise, developed an abscess at that part. In his depressed state the pyogenic cocci were probably able to live in his blood, and the injuries, by setting up the early stage of inflammation, and thus further weakening the tissues, and also by leading to the effusion of blood containing the organisms, gave rise to the formation of abscesses.

Irritating Chemical Substances.—Another important cause of depression of vitality is the action of irritating chemical sub-

stances. The effect of these chemical substances is probably that, when concentrated, they destroy the vitality of the tissue by their caustic effect, and, when more dilute, they set up the early stage of inflammation, which also occurs in the former case in the vicinity of the dead part.

The effect of these substances in procuring a weak spot at which the organisms can develop is, no doubt, the explanation of Kocher's results with regard to acute osteo-myelitis in dogs. He found that if digestive disturbances were induced by the introduction of large quantities of septic material into the intestinal canal; and if, at the same time, a bone was injured by the injection of ammonia, or other irritating chemical substances, into it, acute osteo-myelitis occurred at the seat of injury; while the injection of the chemical substance alone only produced temporary reaction. These experiments, however, were only few in number, and are not completely satisfactory because it is possible that the organisms spread in along the needle track, and did not reach the part from the blood.—It has also been found that if irritating chemical substances are injected subcutaneously into rabbits, and if at the same time large numbers of pyogenic cocci are injected into the veins, suppuration frequently occurs at the seat of injection, the suppuration going hand in hand with the development of the pyogenic organisms which have reached the part from the blood.

Many of the former experiments on the production of suppuration by means of irritating chemical substances which frequently resulted in growth of micro-organisms in the part and, as a consequence, the occurrence of suppuration, show how the presence of irritating chemical substances placed the parts in a condition which diminished their resisting power against the action of micro-organisms.—Grawitz and de Bary found that if croton oil was injected into rabbits subcutaneously, it caused inflammation and sometimes suppuration; if, however, the pyogenic organisms were also present, suppuration always occurred; although these cocci alone in small numbers are unable to produce suppuration in the normal subcutaneous tissue of dogs or rabbits.

If I may venture to apply these facts to the treatment of wounds, it seems to me that if the views which I have attempted to develop as to the importance of a granulation wall as a barrier against micro-organisms are correct, it is questionable whether, in the case of wounds which have become septic, it is well to wash them out with irritating antiseptics, as is so often done at present. That it is well to remove the decomposing discharge, both by free drainage, and also by washing out the wound in some cases, is of course evident, but, where strong, irritating antiseptics are employed, unless they are able to kill all the micro-organisms present in the wound, and thus render it aseptic, the result of their injection might be, I think, that they will injure the granulation wall, and thus produce a weak spot in which the pyogenic cocci present in the wound can develop, and through which they may be able to enter the body. Thus it has been found that in cases of tubercular disease of joints and bones accompanied by suppuration, general tuberculosis—more especially tubercular meningitis—occurs by far most frequently where the sinuses have become septic, and more especially when, in addition, these septic sinuses have been much irritated by futile antiseptic injections. Hence it seems to me that, except in cases where there is reasonable ground for believing that the injection of these antiseptics into septic wounds will completely eradicate the organisms, it is better to avoid the use of irritating antiseptics such as carbolic acid, and if it is thought well to wash away the discharge, to employ some fluid which will not injure the granulation wall.

Except in the case of wounds, the chemical substances which aid in enabling the bacteria to gain a foothold are the products of the organisms themselves. That various bacterial products are highly poisonous is now well known, and in the case of putrefactive and pyogenic organisms, these products are able not only to cause local trouble, but also to set up fever, to depress the vitality of the patient, or, it may be, even to cause death. With regard to these general effects of the chemical products of bacteria, it is unnecessary for me to enter into further detail, for the fact is now so well known that in most books on surgery we find, in addition to septicæmia and pyæmia, a third group of general septic diseases due to the action of these products described under the title of septic intoxication or, as Dr. Matthews Duncan has termed it, "supremia." I may therefore at once pass on to the local effects of the products of bacteria and their action in enabling the organisms to live and multiply in the part.

In some experiments which I performed recently with an

organism described by Hauser, under the name of *proteus vulgaris*—an organism not uncommonly present in putrefying materials—I diluted the growth in gelatine, with a certain amount of water before injection. In some cases, however, I used for dilution, instead of water, boiled meat infusion, in which the same organisms had been growing, that is to say a fluid containing the products of the growth of these bacteria, and I found, for example, that while $\frac{1}{4}$ cubic centimetre of the mixture prepared by the addition of water never killed the animals experimented on, where the dilution was made to the same degree with the boiled meat infusion, they died from the same dose after about forty-eight hours. In the second case a larger quantity of the products of the bacteria, these products being very poisonous, was introduced than in the first case, and to this we must ascribe the difference in the result.—In experiments on guinea-pigs with the cholera bacillus, Hueppe has found that infection occurs more certainly, and with less material if there has been preliminary action on the intestine of the poisonous products of the cholera bacilli, or even of the ptomaines of other bacteria; and Flügge and Wyssokowitsch have shown that bacteria which are not usually pathogenic in the animals employed for the experiments can penetrate into tissues previously weakened by bacterial poisons.

Among the products of the putrefactive fermentation, there are two substances which have been found to be highly irritating, namely, cadaverine and putrescine, and I have previously referred to the experiments made by Grawitz and Scheuerlen, which show that, as the result of the injection of these substances, inflammation and suppuration may occur, according to the strength and quantity of the solution employed. Grawitz found, further, that suppuration certainly occurs if, at the same time that a comparatively dilute solution of cadaverine is injected, pyogenic cocci are introduced.—The chemical products of the pyogenic cocci are also, according to Grawitz, irritating to the subcutaneous tissues of dogs and rabbits, when introduced in sufficient quantity and concentration. Thus, he found that if sterilised cultivations of pyogenic cocci were injected in large quantities into dogs—for example, 4 cubic centimetres of a sterilised cultivation of *staphylococcus pyogenes aureus*—suppuration occurred, the pus being free from organisms.

As regards the products of these pyogenic cocci, Brieger, who is the great authority on this subject, states that he has been unable as yet to obtain any toxine from the cultivations of these organisms. Cultivations of *staphylococcus pyogenes aureus* on moist beef or veal yield large quantities of ammonia, as does also the *staphylococcus pyogenes albus*; the latter produces, in addition, considerable quantities of trimethylamine. *Streptococcus pyogenes* likewise produces ammonia and trimethylamine. That the ammonia must irritate the tissues is, of course, evident, and it is probable that in the nascent state it is still more irritating; while as regards trimethylamine, though it is not an alkaloid, it is in Brieger's opinion probably a descendant of, or very closely related to, the ptomaines, and, when present in considerable quantities in the body, is very hurtful to it. These organisms also produce a peptonising ferment, and can thus peptonise and dissolve coagulated albumen, and this property is of great importance in suppuration. When sown in milk they rapidly set up a pure lactic fermentation, leading to the production of large quantities of lactic acid, as the result of which the milk coagulates if kept for some days at the temperature of the human body. This production of lactic acid is an important fact, as it probably also takes place sometimes in wounds, causing acidity of the discharge, and in abscesses causing the well-known watery pus. Whether ptomaines will yet be found in the case of pyogenic cocci we cannot say; but the occurrence of fever in suppurative diseases may possibly, as Baumgarten suggests, be explained simply by the increased tissue change, as the result of their growth, the products thus formed requiring increased combustion, and perhaps also stimulating the thermic centres, and hence causing elevation of temperature; and in support of this view Baumgarten refers to the fever which occurs in trichinosis, where there is no idea of any action of ptomaines.

Seat of Inoculation and Anatomical Arrangement of the Part.—Much depends also, as regards the effect of these organisms, on the seat of inoculation and the anatomical arrangement of the part. These conditions are of importance in two ways. In the first place, certain organisms will not grow everywhere in the body, they will only grow in certain tissues; and in the second place, in some cases—especially in the case of the pyogenic organisms—the resulting disease varies chiefly according to the anat-

mical arrangement of the part in which the organisms are growing.

Some organisms, such as the higher fungi, seem only to be able to act if they are present within the capillary blood-vessels or large serous sacs; the bacillus of malignant oedema acts only in the cellular tissue; the micrococcus of erysipelas possibly only in the lymphatic vessels. As this is an important matter, I may refer in some detail to a few examples which show the great influence which these conditions exert on the development and the character of the resulting disease. In some experiments which I performed with Hauser's *proteus vulgaris*, I met at first with some very interesting difficulties. I injected the cultivations into the backs of rabbits, and I found that the results obtained varied in a manner very difficult to understand. After considerable investigation I found that the differences depended on the seat of inoculation; that, if the material was injected superficially to the muscles, a different result might be obtained to that which followed injection into the substance of the muscles. Thus quantities of a cultivation which, introduced into the subcutaneous tissue, would only have caused a large abscess, were followed, when injected into the muscles, by the death of the animal; and, further, a small dose, which would have been without apparent effect on the subcutaneous tissue, was sufficient to produce an abscess when injected into the muscles. What the explanation of this difference is I am unable to say. It is possible, however, that some chemical substance in the muscle is readily broken up, and readily gives rise to poisonous compounds; and that this substance does not exist, or is present in less amount, in the subcutaneous tissue. Similar differences, according as injections were made into the subcutaneous tissue or into the muscles, were noticed in the case of several other bacteria.

Perhaps the best example of the great influence exerted by the seat of inoculation and anatomical arrangement of the part is furnished by the disease known in this country as "black leg," in Germany as *Rauschbrand*, and in France as symptomatic anthrax. This disease has been investigated by a number of observers, chiefly by three French observers, who have worked together, namely, MM. Arloing, Cornevin, and Thomas. The disease affects chiefly cattle and sheep—more especially cattle—and is characterised by the rapid appearance of irregularly limited swellings of the skin and muscular tissues, these swellings being at first very painful and tense, but rapidly becoming painless and crepitating. The disease is accompanied by fever, which is often very high, and it is almost always fatal, usually after a duration of from thirty-six to forty hours. The cause of the disease has been demonstrated to be a bacillus which grows without oxygen, and thus belongs to Pasteur's class of anaerobes. These bacilli are remarkable in various ways, more especially in the conditions under which they exert their pathogenic action. In order to cause the death of the animals, the organisms must be introduced either into the subcutaneous tissue or into the muscles; if they are injected into the veins or into the bronchi they do not cause the death of the animal, but apparently after a time die out, leaving the animal, however, protected against the disease. And I have already mentioned that if, after the virus has been injected into the veins, a bruise is caused in some part of the body, the organisms reach that spot from the blood, grow there, and set up the disease. If inoculations are made quite at the tip of the tail in cattle, the result is only a moderate amount of reaction, even when large quantities of the material are introduced; the more proximal on the tail is the seat of inoculation, the more readily is a result obtained. The explanation of this fact is apparently partly the dense nature of the connective tissue at the tip of the tail, and partly also the low temperature of the part. That the density of the tissue in the tails of cattle interferes with the spread of the infection is evident, because sheep, at the tips of whose tails the cellular tissue is loose, react markedly on inoculation in that part. As regards the temperature of the part, it has been found that if, after inoculation, the tail is wrapped in bad conductors of heat, the local temperature can be so raised that considerable reaction occurs, and *vice versa* in the case of sheep, if, after inoculation, the part is kept cool by the application of ice-bags, the violence of the local reaction is much reduced.

As regards the pyogenic organisms, most of them act in the cellular tissue to which they gain access, as a rule, after the destruction of the epithelium. The gonococcus is, so far as we know, the only pyogenic organism in man which is able to penetrate uninjured epithelium; and with regard to the gonococcus, it is very striking that it only attacks certain mucous membranes,

and apparently cannot develop in any other tissue of the body, unless, perhaps, in the joints in which, according to Kammerer, it is present in some cases of gonorrhoeal rheumatism. (It must be said, however, that some investigators have failed to confirm this observation.) Bumm states that pure gonorrhoeal pus may be injected into the subcutaneous cellular tissue without causing any reaction, and that if, after twenty-four hours, an incision is made, and some of the pus which was injected is removed, it will be found that the cells are still in good condition, but that the cocci have disappeared; this fact is of interest also as showing that pus, apart from the micro-organisms which it contains, does not exert any pyogenic action. Also, as I have previously said, when suppurative bubo occurs after gonorrhoea, the staphylococcus pyogenes aureus or albus is present in the pus from the gland, and not the gonococcus; suppurative bubo being therefore the result of a mixed infection, and not a necessary complication of gonorrhoea. The same is the case in abscesses outside the urethra in connection with gonorrhoea.

Kitt has found that, in the case of the coccus of mastitis in cows, the organisms only exert their pathogenic action when they are present in the ducts or acini of the mamma; if injected directly into the tissue of the mamma they cause no suppuration.

The anatomical arrangement of the part is probably a very important factor in the production of acute osteo-mylitis. This disease is, as we have seen, due to the action of the pyogenic cocci, and it not unfrequently stands apparently in some relation to an injury. But the injury and the presence of the cocci do not explain the whole of the etiology of the disease, more especially they do not explain why it is that the disease is almost entirely limited to certain bones and to certain parts of bones. Not that most of the bones in the body may not, under certain circumstances, become the seat of this affection, but as a rule the disease has certain very favourite seats, such as the femur, especially its lower end, the upper and lower ends of the tibia, the upper end of the humerus, and the radius. Now these are the bones which grow most rapidly, and in them the disease commences during the period of growth, and most usually in the neighbourhood of the epiphysal line, where the growth is of course most active. Thus the fact that the bones are growing helps apparently to determine the seat of the disease, possibly because there is a large amount of young indefinite tissue at these parts, possibly also because there are plenty of blood-vessels, and also perhaps because the circulation in the ends of the bone is apparently less rapid than elsewhere (Neumann). It is interesting also to note, as showing probably the influence of similar conditions, that when this disease attacks infants, it is usually limited to the neighbourhood of the epiphysal line, giving rise to acute epiphysitis. At the same time, the anatomical peculiarities will not suffice to explain all the facts because in growing animals, belonging to species not insensitive to this poison, the disease is not produced by injection into the circulation, unless some other determining cause, such as injury, comes into play; and because also the disease not infrequently occurs after acute fevers, such as typhoid fever. As regards the anatomical arrangement of the part in its relation to acute osteo-mylitis, all that we can say therefore is that there is some peculiarity in growing bones, not necessarily limited to the growth at the epiphysis, which has an important influence on the production of the disease.

PLACENTA PRÆVIA.¹

By ROBERT BARNES, M.D., F.R.C.P.,

Honorary President of the British Gynaecological Society; Honorary Fellow of the King and Queen's College of Physicians in Ireland.

THE theory and treatment of placenta prævia have been so frequently the subject of discussion, that it may seem to require an apology for bringing it before the Section. But it must, I think, be conceded that the conflicting ideas or dogmas urged as to the proper treatment prove that the true theory that can alone govern a rational scheme of treatment is not yet fairly recognised.

It will be my endeavour to put this fundamental point in a clearer light. I cannot better expose the unsettled and irrational practices that prevail than by briefly stating some of them.

¹ Read in the Section of Obstetrics at the Annual Meeting of the British Medical Association held in Dublin, August, 1887.

Some still advocate the old "*accouchement forcé*," pure and simple, or with slight mitigation, and these have the recent authority of Spiegelberg.

Schroeder, perhaps the greatest representative of modern German obstetric science, sums up the treatment thus: "Rupture the membranes, draw down a foot, and wait during extraction."

Some contend that the whole treatment consists in bimanual turning. This operation finds, as I long ago pointed out, useful application (*Lancet*, 1861); but it is really the "*accouchement forcé*," mitigated. Some think the whole treatment consists in plugging.

The following criticism by Ludwig Miller in his work on *Placenta Prævia* (1877) is, with few exceptions, singularly just: "Smellie did not follow any one method exclusively, but acted according to the indications of the case in hand. In this he made a step in advance, which places him higher than all his predecessors, and many of his successors."

It may be urged generally against the more rapid or forcible methods that they are fraught with danger to the child. Following the practice of the elder Simpson and of some of the older teachers, those who advocate these methods assume that the conditions are so perilous to the child that they are justified in leaving the child out of consideration, well satisfied if they can save the mother.

I cannot stop to discuss the fallacies which entangle this argument. I will simply state, as the result of extensive clinical experience and anxious casuistical analysis, that those methods which are the most successful in saving the mother are often exactly those which give the best chance to the child. Here, as in other of the great clinical problems in obstetrics, the guiding principle should be to seek for a solution which offers the greatest security for both mother and child, not condemning either.

It is no longer permitted to us, without ample proof of clear necessity, to sacrifice the child in order to save the mother. The cases in which the two lives are supposed to stand in antagonism are vanishing before the light of modern science and skill. And in no conjuncture is this more true than in the treatment of placenta prævia. Countless infants have been sacrificed on the altar of false theories. My own experience gives 33 per cent. of children born alive; and that, concurrently with a larger saving of mothers than has been secured by other methods.

A gross fallacy, which vitiates the teaching and practice of many men, is to regard the particular manipulation which they most affect as constituting the whole treatment of placenta prævia. If they had grasped the true theory, and had the faith that leads to action, they would have seen that there is no one method of treatment, but that several operations come into use in accordance with the stage of the labour, and the particular conditions of the case in hand.

Since I first sketched my theory of placenta prævia in the *Lancet* in 1847, and especially since the publication of my *Lettomanian Lectures* in 1857, the leading idea of that theory has been largely recognised. Thus it is now admitted that there is a well-defined boundary between the lower zone of the uterus and the body of the uterus proper; and that the lower zone is distinguished from the upper zones of the uterus by peculiar attributes.

The theory of placenta prævia, developed from my original conception is depicted in the following diagram, (No. 1), and is summarised as follows:

The pregnant uterus is divided into three zones: the upper or fundal (*f.z.*, Diagram 1); the equatorial (*e.z.*) and the lower (*l.z.*). The fundal zone is divided from the equatorial by an imaginary line (1-2), the upper polar circle. This line has not been anatomically demonstrated, nor has it been recognised by anyone but myself; but it serves to mark a distinction, which I believe is real, between the properties of the upper and the equatorial zones in their relations to placental attachment and to hæmorrhage.

The equatorial zone is divided from the lower zone (commonly, of late, called the lower uterine segment), by the line 3-4. This is Barnes's boundary-line (1847-1857), since then sometimes called Braune's os internum, Bandl's ring, or Schroeder's contractions-ring.

The fundal zone (5) is the seat of fundal placenta, the region of safest and most typical normal attachment. The equatorial zone (7) is the seat of lateral or equatorial placenta. It disposes, I believe, to what is called accidental hæmorrhage, but may be fairly regarded as a comparatively safe normal attachment. This is still more true when the placenta is attached partly in the fundal zone and partly in the equatorial, as