The Bacteria of the Puerperal Uterus, with Especial Reference to the Presence of Hæmolytic Streptococci.*

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THE problems presented by the relation of the streptococcus pyogenes to puerperal infection have been the subject of many investigations during the last few years. This organism is undoubtedly the cause of the great majority of cases of severe infection, and is usually found in abundance in the uterine discharges. It is, however, not infrequently present in the vagina and in the uterine secretion after delivery in cases pursuing a normal course. The streptococcus has also often been found in the slighter forms of infection which are clinically regarded as being of sapræmic origin. It is, therefore, of great importance to determine whether the streptococci found in severe forms of infection are essentially different from the saprophytic types of the organism or not. The remarkable variations in the infective power of streptococci have lead to many attempts to classify the various types with the object of bringing their morphological and cultural features into relation to their pathogenic power. Efforts have been made to detect specific differences between varieties of streptococci according to the length of their chains, their mode of growth and staining reactions, their power of agglutination and their virulence for animals. None of these features, however, have been found to be constant. The results of recent experiments on immunisation of animals carried out by Natvig, Zangemeister and Meissl appear to show that all facultative anaerobic streptococci are essentially of one stock. Scheib, who has closely investigated this question, states that it is impossible to distinguish between streptococci existing as saprophytes in the lochial discharge and those causing puerperal infection. During the last few years great stress has been laid upon the hæmolytic power of streptococci as an indication of their virulence, and it is to the solution of this question that our observations have been mainly directed. Before considering our results in detail it may be

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desirable to review briefly the present-day knowledge of the organisms found in the vaginal secretion and in the lochial discharge of healthy individuals.

THE VAGINA. An enormous amount of research has been devoted to the investigation of the vaginal secretion in healthy women during pregnancy with the object of determining the presence or otherwise of organisms capable of producing infection. Microscopic examination of the secretion reveals the presence of many organisms, but accurate information can only be obtained by cultural methods, and for this purpose it is essential to remove the vaginal secretion without any contamination from the vulva. This may be carried out by separation of the labia, and the introduction of a platinum wire loop into the vagina, great care being taken to avoid contact with the vulva. Many observers have used a speculum. This, however, appears to be inadvisable, as it almost inevitably results in the introduction of organisms from without. A method which is probably the least open to objection consists in the introduction of a tube as first adopted by Krönig and Menge.

The earlier observers, such as Gonner, Winter, and others, found many bacilli and cocci in the vaginal secretion; these were mainly anaerobic in type and were not pathogenic for animals. Döderlein, in 1892, published his classical paper, based upon the examination of the vaginal secretion of 195 pregnant women. He described two forms of secretion as existing in pregnancy.

In the normal condition the vaginal secretion is scanty, white in colour, and cheesy in consistence, containing epithelial cells and leucocytes; it is intensely acid in reaction and is characterized by the presence of long anaerobic bacilli. These organisms appear to produce lactic acid and to exert a bactericidal influence on pyogenic bacteria introduced from without. In the other type considered by Döderlein to be pathological, the secretion is profuse, yellowish-white in colour, containing many leucocytes and epithelial debris; it is only slightly acid in reaction and contains a large number of micro-organisms of various kinds, including streptococci, which were present in 10 per cent. of the cases observed by him. Further observations have shown that whilst the acid vaginal secretion is unfavourable to the growth of organisms the bacillus of Döderlein itself only plays a subordinate part, and that although the two forms of secretion undoubtedly exist, it is of little practical value to distinguish between them.

The researches of Stroganoff, Dubendorfer, Bergholm, Burghardt, Vahle, Stolz, and others have in the main confirmed these conclusions. All these observers have found streptococci to be present in the vaginal secretion in a proportion varying from 10 to 15 per cent. of cases. Bumm and Sigwart, in 1904, reported that they were able to cultivate streptococci in 30 to 50 per cent. of women examined

during pregnancy, the secretion being obtained by the use of a speculum.

On the other hand, Krönig, in a series of 167 cases, was unable to demonstrate the presence of streptococci, and concluded that the vaginal secretion should be regarded as free from pyogenic organisms, with the exception of the gonococcus which was occasionally present. He was able to cultivate, however, a large number of anærobic organisms including an anærobic streptococcus; none of these organisms, possessed any pathogenic power. Whitridge Williams and Bergland have also published a series of observations which tend to show that if sufficient precautions are taken to avoid vulvar contamination no pyogenic organisms will be found in the vagina during pregnancy.

It seems probable that these widely different results are attributable partly to the absence of any uniform method of removing the secretion and partly also to the different culture media which have been adopted. Thus those observers who have used alkaline agar only, have rarely discovered streptococci; if, however, the agar is combined with a reducing substance, such as grape sugar, streptococci are found in a considerable proportion of cases, the secretion being obtained without any probability of vulvar contamination (Bergholm, Böhne, Stähler, Winkler).

Walthard gives the following list of organisms which have been found to exist in the vagina of pregnant women, and which are indistinguishable from those present in puerperal infection.

- (1) Facultative anærobic streptococci of the type of streptococcus pyogenes puerperalis—(Döderlein, Böhne, Stähler, Winkler, Bumm.)
- (2) Facultative anærobic diplo-streptococci. (Natvig.)
- (3) Anærobic streptococci. (Krönig and Menge.)
- (4) Staphylococci of the type of staphylococcus albus.
- (5) Bacteria of the coli group. (Bensis, Kottmann, Walthard.)

The following organisms are also found in rare instances and usually associated with offensive secretion.

- (6) Bacillus funduliformis.
- (7) Pseudo-tetanus bacilli.
- (8) Bacillus ærogenes capsulatus.

We must therefore conclude that organisms indistinguishable from pyogenic streptococci, together with diplococci and the bacterium coli, are not unfrequently present in healthy women during pregnancy, especially in the lower part of the vagina.

THE CERVIX. The cervical canal during pregnancy is occupied by a plug of firm, clear mucus which effectually closes the uterine cavity. The secretion of the cervical glands appears to be an unsuitable culture medium for bacterial growth and, moreover, frequently contains phagocytes which exert a definite bactericidal

influence. The vaginal portion of the cervix and even the lower part of the cervical canal contain many organisms, and these are much increased in numbers if erosions or lacerations are present.

Varaldo has recently investigated the cervical secretion in 32 pregnant women in whom these conditions existed, and was able to detect streptococci, gonococci and bacteria of the coli group in a considerable proportion of cases. Foulerton and Bonney also, in examining the cervical secretion of 30 non-pregnant women, found staphylococci, diphtheroid bacilli, and various forms of diplococci. None of these organisms, however, appear to be able to penetrate the protective zone of the cervical secretion during pregnancy, but it is not improbable that after delivery they ascend into the uterus and may become a source of infection.

All observers agree that the cavity of the uterus is free from organisms during normal pregnancy.

BACTERIOLOGY OF THE GENERATIVE TRACT DURING THE NORMAL PUERPERIUM.

THE VULVA. After delivery the vulval orifice is bathed in lochial discharge and a large number of organisms are almost constantly present. Investigations on the vestibular secretion by Natvig, Pilz and others, have demonstrated the presence of streptococci, staphylococci, and the bacterium coli in a large proportion of cases. These organisms usually appear to possess little virulence, but it is quite possible that if they are conveyed into the vagina they may develop some degree of infective power.

THE VAGINA. The vaginal discharge during the first 24 hours after delivery contains relatively few organisms. This is apparently the result of the cleansing process which occurs during labour as a result of the passage of the child's head with the placenta and membranes; it is possible also that the bactericidal power of the fresh blood may exert some influence. After the second day, however, a large number of organisms may be cultivated from the vaginal lochia. The bacillus of Döderlein, if present, disappears, and the organisms existing in the vagina before delivery multiply rapidly in the alkaline secretion. According to the observations of Krönig and Natvig organisms from the vulva frequently ascend into the vagina during the early days after delivery.

THE UTERUS AFTER DELIVERY. The bacteria present in the uterine lochia have been investigated by numerous observers with widely different results. The early observations of Döderlein, Winternitz, von Ott and Czerinewski appeared to show that the lochial discharge was sterile in 70 to 80 per cent. of cases. Streptococci and pyogenic organisms were found in 7 per cent., and in the remainder anaerobic saprophytic bacteria were present. Franz, however, in 1898, was

able to detect pyogenic organisms in every case in the later days of the puerperium. Subsequent observers, such as Burghardt, Wormser, Stähler, Vogel, and others have been able to cultivate organisms in from 20 to 50 per cent. of cases after the third or fourth day. Krönig, in a series of afebrile women found that streptococci and staphylococci were not infrequently present in the uterine cavity by the end of the third day, usually disappearing after the seventh day when the lochia became sterile. Organisms undoubtedly ascend from the vulva and vagina, even in women who have never been examined, and it has been demonstrated by Hellendahl that this takes place along the blood coagula which are usually present in the upper portion of the vagina and in the cervical canal.

Special significance must be attached to the existence of streptococci in the normal lochial discharge. These organisms appear to be present in 10 to 20 per cent. of all cases in the vaginal secretion and often in the uterine cavity.

Bumm and Sigwart, in a careful series of observations, discovered streptococci, in the lochial discharge, in 50 to 75 per cent. of cases examined within a few days of delivery.

Leo examined the lochia of 38 afebrile puerperal women and found streptococci in the vaginal secretion in 50 per cent. of cases, and in 17.6 per cent. these organisms were also present in the uterine lochia. Schenk and Scheib have also found these organisms in the uterine secretion after the seventh day in at least one-third of their cases.

Stolz investigated the contents of the uterus in a series of normal cases on the fourth day after delivery, and found that organisms were present in no less than 80 per cent. Even in women who had never been examined streptococci were found in the uterine secretion after the fourth day of the puerperium in 36.9 per cent. of cases. In some of these cases febrile symptoms developed which he believes may be attributed to slight traumatism inflicted in the removal of the secretion. He observed that the number of organisms in the uterine cavity diminishes during the later days of the puerperium, a feature which points to the uterus possessing the faculty of "self cleansing."

Mansfeld has recently examined the intra-uterine secretion of 40 afebrile puerperal women on the fourth and fifth days after delivery. He was able to detect organisms in 60 per cent. of cases, streptococci being present in 22.5 per cent.

In all these observations the secretion was obtained by the introduction of a glass tube into the uterine cavity, and it is impossible in this way to avoid contact with the secretion of the lower part of the cervical canal, and it is therefore probable that the cavity of the uterus itself is sterile in a greater proportion of cases than would appear from these figures.

Many attempts have been made to investigate the secretion in

the upper portion of the uterus without contamination by the cervical discharge, and the results show a much greater relative proportion of sterile lochia. Thus Little found that the cavity of the uterus immediately after labour was sterile in 92 per cent. of cases, and on the third day in 62 per cent. of afebrile cases. In only one instance was he able to detect the presence of the streptococcus pyogenes.

Nicholson and Evans believe that the positive results obtained by a large number of observers are due to faulty technique, and that the secretion in the uterus is sterile in normal cases throughout the puerperium. Their observations were made by the introduction of a speculum along the cervical canal, through which a tube was passed into the uterine cavity. In a few cases streptococci were observed, always, however, associated with symptoms of infection.

From this brief review of our knowledge, and in spite of much difference of opinion it must be concluded that organisms closely resembling those present in puerperal infection often exist in the upper part of the vagina, and in the cervical secretion shortly after delivery, and that this is frequently followed by invasion of the uterine cavity as a result of the spontaneous ascent of organisms. Our observations were made in the early days of the puerperium after disinfection of the vaginal portion of the cervix. In a large proportion of cases a positive result was obtained, but we think it is probable that in many instances the organisms were only present in the cervical canal and lower portion of the uterus.

It is important to know how far examinations and manipulations promote the entrance of organisms into the uterine cavity during the puerperium. Stolz made a series of investigations on the 4th and 9th days after delivery, and found that repeated examinations made with the sterile hand, and manipulations such as the application of forceps, or version, had little influence on the organisms present in the uterine cavity. The influence of the third stage of labour was, however, very definite. He found that if this was under one hour's duration the proportion of cases in which bacteria was present increased by 10 per cent. This is probably due to the fact that if the third stage is unduly hastened the liability to hæmorrhage and retention of portions of placenta or membranes is much increased. These results were also confirmed by Little, who found that lacerations of the perineum, vaginal examinations and operative delivery, provided that complete asepsis was maintained, exerted little influence on the "germ content" of the uterus during the puerperium.

HÆMOLYSIS OF STREPTOCOCCI. The early observations of Bordet (1897) and Marmorek (1902) showed that many streptococci possess a hæmolytic power. Schlesinger, in 1903, conducted a series of experiments with the object of determining the significance of hæmolysis, but his results were not conclusive. Schottmüller was

the first who claimed that it was possible to determine the virulence of an organism by its power of hæmolyzing human blood. For this purpose he made use of blood-agar as a culture medium and recognized three varieties of streptococci:—

- (1) *The streptococcus pyogenes*. This is the organism found in puerperal infection. Within a few hours of inoculation it forms on the plates definite white areas indicating destruction of the red-blood corpuscles by hæmolysis.
- (2) *Streptococcus mitior or gracilis*. These organisms produce areas of brown discolouration around the point of inoculation due to the formation of methæmoglobin but without obvious destruction of the corpuscles. This organism is often found as a saprophyte in the buccal and nasal cavities, and has only slight pathogenic power. It is also the organism frequently present in the vulvar and vaginal secretion.
- (3) *Streptococcus mucosus*. This organism develops slowly in small colonies, but shows no hæmolysis. This type of streptococcus is observed rarely and does not appear to possess any pathogenic power.

Schottmüller, who has for several years made a large number of observations, claims that the hæmolytic power is proportionate to the virulence of the organism, and he regards the presence of a hæmolytic streptococcus as clearly indicating a pathogenic variety of the organism. His investigations have been largely confined to the organisms found in the blood in cases of septicæmia which always appear to possess a high degree of hæmolysis.

These conclusions have not been altogether confirmed by recent work, since many observers have shown that hæmolysis may be produced by organisms of little virulence.

Natvig made a large number of experiments on the hæmolysis of streptococci, and found that this is largely dependent on the mode of culture, and that many organisms possessed of little virulence showed very decided hæmolytic power, and that, in general, variations in hæmolysis do not run parallel to the virulence of the organism. It has not been found possible by cultural methods to convert a non-hæmolytic streptococcus into a hæmolytic organism. If, however, streptococci are inoculated into animals, such as mice, their virulence becomes intensified and this is often associated with the development of hæmolytic power.

The question as to the significance of the presence of hæmolytic streptococci in the lochial discharge or in the blood, however, can only be decided by systematic clinical observations, and considerable evidence exists that the organisms present in severe puerperal infection always show a marked capacity for hæmolysis.

Fromme has published the results of his observations on the presence of hæmolytic streptococci in puerperal women.

In a series of 100 normal pregnant women streptococci were found in the vaginal secretion in no less than 27. None of these were obviously hæmolytic, though in 3 cases a slight discolouration of the blood was observed around the colonies.

In 36 observations made on the lochial discharge of afebrile women after delivery he discovered streptococci in 19; none of these, however, were hæmolytic, and according to his observations the streptococci found in the lochia of afebrile puerperal women possess no hæmolytic power. They produce an area of brown discolouration on agar plates but no destruction of hæmoglobin, thus belonging to the group of streptococcus mitior.

In 14 women who presented signs of severe infection, hæmolytic streptococci were found in the lochia and, in 10 cases of general infection, he was able to obtain from the blood hæmolytic streptococci in each instance.

Gonnet, of Lyons, has also published figures which appear to confirm the conclusions of Fromme. In the vaginal secretion of 100 pregnant women he found streptococci in 16 per cent., but in no case did they possess any hæmolytic power and the puerperium was afebrile in each case. He also examined the lochial secretion of 100 women after delivery from the 5th to the 7th day. In 90 per cent. of these no streptococci were present. In 6 cases a streptococcus was found. This showed no hæmolytic power, and in these cases also the puerperium was afebrile. In four instances a typical hæmolytic streptococcus was detected and each patient developed acute infection. Gonnet also relates six cases of general septicæmia in which hæmolytic streptococci were cultivated from the blood in large numbers. All of these patients died.

The results of these observers appear to show that hæmolytic streptococci are never found in the vaginal secretion during normal pregnancy, or after delivery, and that if hæmolytic organisms are present puerperal infection has occurred.

Veit goes so far as to state that the presence of hæmolytic streptococci in the lochial discharge is to be regarded as a sign of the presence of grave infection, and that in these cases no local therapeutic measures should be undertaken on account of the danger of generalisation.

Freytmuth, who has recently made a contribution to this subject, entirely disputes the conclusions arrived at by Fromme. He isolated streptococci from the vaginal secretion of 20 pregnant women and compared these with a strain of streptococci derived from a fatal case of puerperal infection. He found no constant relation in the hæmolytic power, and regards hæmolysis as of no value in distinguishing pathogenic from saprophytic varieties of streptococci.

Heynemann has recently published some observations on the results of the examination of the lochial discharge in 125 afebrile puerperal women following in detail the technique of Schottmüller.

In only 22 of these cases was he able to detect hæmolytic streptococci. In 4 of these the organisms were also present in large numbers in the blood, and each case terminated fatally. In the remaining 18 the patients suffered from symptoms of severe local infection of the uterus, but the blood remained sterile throughout. All of these cases made good recoveries with simple treatment. He regards the presence of hæmolytic streptococci in the lochial secretion as of great practical value as in a doubtful case it may serve to complete the diagnosis. He further believes that it is not necessary to introduce a tube into the uterus, but that if these organisms are found in the secretion of the upper portion of the vagina a clinical diagnosis of the existence of infection may be made.

From these observations it is clear that in the great majority of cases of severe infection, the streptococci present possess well-marked hæmolytic power. The question, however, as to whether we really possess in this hæmolysis an absolute means of differentiating between saprophytic and pathogenic organisms is not yet settled.

PERSONAL OBSERVATIONS.

Method of investigation. We have examined the lochial discharge from the cavity of the uterus in a series of 58 cases between the second and ninth days after delivery. The technique adopted in the removal of the secretion is important, as it is essential that it should be obtained without contamination by the vaginal discharge. The patient is placed in the lithotomy position and the vulva thoroughly cleansed. The labia are now held widely apart and a Sims speculum is introduced along the posterior vaginal wall. The cervix is thus readily exposed and the anterior lip is seized by a fine volsella. The vaginal portion is now thoroughly cleansed by sterilized absorbent wool. A curved glass tube (after the pattern introduced by Döderlein) is passed into the uterus, up to the fundus. Suction is made by means of a syringe and as much lochial discharge as possible obtained from the uterine cavity.

Preparation of the plates. The blood was obtained from the median basilic vein of a healthy individual. This can be very simply carried out and causes a very small amount of discomfort. The arm is tightly bandaged below the shoulder and the skin around the elbow disinfected; a small incision is now made over the distended vein in order to avoid any possibility of contamination from the skin. For the removal of the blood a glass syringe after the pattern of Luer was used. It is essential that this should be previously washed out with a sterile solution of citrate of potash in order to prevent premature coagulation of the blood. The needle is

Hæmolysis produced by streptococci on blood agar plates.

introduced into the vein in a direction opposite to the blood flow. The syringe rapidly fills, 10 cc. of blood being usually removed. This is now immediately added to a solution of agar in a test tube in the proportion of 2 cc. of blood to 5 cc. of agar; after thoroughly mixing the solution is poured on to the Pétri plates.

Mode of culture. The contents of the uterine tube were immediately smeared on to the surface of freshly prepared blood agar by means of a spatula made of platinum foil. The plates were incubated at a temperature of 37°C. in an inverted position, in order to prevent condensation of water on the surface of the agar. The plates were examined at the end of 24 and 48 hours and coverglass preparations made for each variety of colony present on the plate. In many instances sub-cultures were also made in order to identify the type of organism. Hæmolysis was usually observed at the end of 24 hours, but in some cases it was necessary to wait until the end of the second day. The appearances were quite characteristic, each hæmolytic colony being surrounded by a characteristic white zone of absorption. Microscopic examination of the hæmolytic area showed complete disappearance of the hæmoglobin. The anaerobic cultures were made by mixing the blood with recently boiled glucose agar. The plates were then placed in a glass vessel from which all the air was exhausted by means of a water pump.

Results. The day after delivery on which the secretion was removed was as follows:—

2nd day	15 cases	sterile	2	organisms found in	13
3rd "	20 "	"	5	" "	15
4th "	6 "	"	1	" "	5
5th "	6 "	"	0	" "	6
6th "	4 "	"	2	" "	2
7th "	2 "	"	0	" "	2
8th "	3 "	"	2	" "	1
9th "	2 "	"	0	" "	2
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Total	58		12		46

The contents of the uterus were sterile in 12 cases only, *i.e.*, a proportion of 20 per cent., and it is noteworthy that in 5 of these cases no vaginal examination had been made throughout. In 80 per cent. of cases bacterial growth appeared on the blood agar plates, usually within 24 hours of inoculation. The organisms found were as follows:—

Streptococcus pyogenes: Hæmolytic, 5 cases; Non-hæmolytic, 7 cases.

Staphylococcus pyogenes: Hæmolytic, 26 cases; Non-hæmolytic, 27 cases.

Diplo-streptococcus: This appears to be the organism described by Natvig as the "para-pneumococcus," 14 cases.

Bacilli of the Coli Group: 10 cases.

Pseudo-diphtheritic bacilli: 18 cases.

Proteus bacilli, 3 cases.

The anærobic bacteria present in the secretion were cultivated in 10 cases. In 2 the plates remained sterile. The organisms present in the other cases were anærobic staphylococci and lanceolate diplococci, which frequently showed some power of hæmolysis.

The staphylococci. The staphylococcus albus was the organism usually present, but in a few instances colonies of the staphylococcus aureus were observed. Hæmolytic and non-hæmolytic colonies frequently occurred together, but the hæmolysis was often not visible until the end of 48 hours. It was noticed in making sub-cultures that the non-hæmolytic variety of staphylococcus liquified gelatine much more rapidly than the hæmolytic form.

Streptococci. The hæmolytic streptococci formed long chains and grew abundantly in peptonised broth producing a thick flocculent deposit. The pathogenic power of two strains of hæmolytic streptococcus was tested by inoculation into rabbits. One of them, derived from a case which manifested signs of infection produced no lesions; the inoculation was not, however, made until the streptococcus had been cultivated for three weeks. In another case the hæmolytic streptococcus from a normal puerperium was inoculated into the hind leg of a rabbit; this was followed by the formation of a large abscess with local lymphatic infection. No organisms, however, were found in the pus and no growth was obtained on culture, thus showing that the organism was possessed of very slight pathogenic power.

Pseudo-diphtheria bacilli. In some cases these bacilli were very short and resembled the Hofmann bacillus, but usually the organisms were microscopically indistinguishable from the Klebs-Loeffler bacillus and showed granules which stained by Neisser's method.

Diplococci. These organisms were present in 20 per cent. of cases and were of two distinct types. Both forms were facultative anærobes growing equally well, aerobically and anærobically. Many of the colonies showed well marked hæmolysis.

One of the organisms presented all the features of the para-pneumococcus described by Natvig. A similar organism has also been found in the urethral secretion of healthy men by Pfeiffer.

The other type of organism met with was a lanceolate diplococcus. This appears to be the organism described as occurring in puerperal infection by Foulerton and Bonney, and is indistinguishable from the pneumococcus.

These organisms are, according to the observations of Natvig, in their cultural and biological features, closely allied to the streptococcus pyogenes.

Bacillus coli. Organisms of this type were present in 10 cases, always associated with other organisms, especially, staphylococci and diplococci.

Proteus bacilli. These organisms were present in three cases. They have been frequently found in the lochial secretion, and do not appear to be of much importance.

CHARACTER OF THE PUERPERIUM. In 53 patients the course of the puerperium was afebrile throughout. In 5 instances a rise of temperature was observed. The notes of these are briefly as follows:—

In two cases (Nos. 27 and 52) the temperature rose to 101·4 and 101·6 respectively on the evening of the day on which the culture was taken. This was the only rise of temperature during the puerperium. In both cases hæmolytic staphylococci, and in one instance a non-hæmolytic streptococcus were cultivated from the lochial secretion. The temperature in each case fell to normal within 24 hours, and it is probable that the slight fever was the result of traumatism produced by the introduction of the uterine tube.

In one instance (No. 48), a multipara, labour was natural, but the temperature rose to 103·8° 48 hours after delivery. The uterine cavity was immediately explored and douched, clots being removed; this was followed by a gradual fall of temperature which became normal on the 7th day. Cultures taken on the 6th day showed the presence of diplococci and the bacterium coli.

In the fourth case of pyrexia the patient (No. 4), a multipara, was admitted during labour on account of severe accidental hæmorrhage. The membranes were artificially ruptured and delivery ensued without further bleeding. The temperature reached 100° on the second day, and a culture of the uterine contents showed the presence of hæmolytic staphylococci. On the third day the temperature rose to 103°. The uterus was now thoroughly disinfected and this was followed by marked improvement, the temperature becoming normal on the seventh day. This appears to have been an example of staphylococcic endometritis of a relatively mild type.

The last case is of considerable interest, as it is the only instance of infection associated with the presence of hæmolytic streptococci in the uterine cavity.

The patient (No. 50), a secundipara, was admitted to hospital during labour. Delivery was effected by forceps, and this resulted in some degree of laceration of the perineum.

The temperature rose to 103° on the third day. Cultures taken from the uterus showed the presence of streptococci possessing very marked hæmolytic power. On the fourth day the uterine cavity was explored and douched. The temperature fell the same evening to

101°, and became normal in 3 days. The lochial discharge continued to be profuse and purulent for seven days.

This case must be regarded as one of localised streptococcic infection of the endometrium.

These results show that organisms are frequently found in the uterine cavity as early as the second or third day after delivery.

It is, however, impossible by the ordinary methods of obtaining lochial secretion to avoid contact with the cervical canal, and it seems probable that in many of these cases the organisms had not reached the upper portion of the uterine cavity. Our figures show a much higher percentage of cases of bacterial invasion in the early days of the puerperium than those of many other observers; this is perhaps attributable to the facts that we have used for cultures agar mixed with human blood, which is an extremely favourable medium for all forms of bacterial growth, and that the plates were placed in the incubator within a very short time after inoculation. The organisms present are precisely those which have been frequently found in the vaginal secretion during pregnancy. It is however probable that these are reinforced by bacteria from the vulva ascending into the vagina either spontaneously or as the result of manipulations during delivery. In a considerable number of cases some operative interference was required, and this probably exerts some influence in facilitating the early invasion of the uterine cavity. On the other hand, organisms were found with almost equal frequency after normal labour, and even in cases in which no vaginal examination had been carried out.

The course of the puerperium was in the great majority of cases entirely uninfluenced by the presence of the organisms. It is probable that in many instances they only exist in small numbers and possess little, if any, pathogenic power; moreover, the uterine cavity speedily becomes protected by an epithelial cellular layer which, according to the observations of Krönig, is often fully developed by the end of the 5th day.

The primary object of this investigation was to test the conclusions of those observers who maintain that the presence of hæmolytic streptococci in the vaginal or uterine secretion after delivery must be regarded as pathognomonic of the existence of infection. There can be no doubt from the clinical observations of Schottmüller, Gonnet, Fabre, Fromme and others, that the streptococci present in cases of severe infection are characterized by great hæmolytic activity. This is not only observed in the organisms obtained from the uterine cavity, but is a characteristic feature of the streptococci which may be cultivated from the blood. It has also been observed that the streptococci present in the peritoneal fluid in

cases of infection are always hæmolytic. Our results show that hæmolytic streptococci may exist in the lochial secretion without any evidence of infection. Streptococci were present in 12 cases in all, *i.e.*, in 20 per cent. of the total number. In 7 instances the organisms showed no hæmolytic power and correspond to the type of streptococcus mitior of Schottmüller or the streptococcus gracilis of other observers. In all of these cases the puerperium was normal except that in one instance the temperature rose to 101·6 a few hours after the intra-uterine culture was obtained, and this is probably to be regarded as directly due to the introduction of the tube. In 5 cases hæmolytic streptococci were cultivated. In 4 of these the puerperium was afebrile throughout, but in one case (No. 43) febrile symptoms developed; these, however, remained limited to a superficial infection of the endometrium. It must therefore be acknowledged that streptococci, indistinguishable from those found in severe forms of infection, may exist in the lochial discharge of puerperal women even in the early days of the puerperium without causing any rise of temperature. This may be explained either by the fact that hæmolysis is often produced by organisms possessing a very slight degree of virulence, or we must assume that these patients possess considerable resisting power to infection. It is, therefore, not possible to claim that the hæmolysis forms an absolute distinction between the saprophytic and slightly virulent organisms and those which are pathogenic. If, however, hæmolytic streptococci are discovered in a case of fever after delivery it is probable that they are the causal agents of the infection.

The question as to whether the saprophytic streptococci existing in the vagina before delivery are capable of developing infective power is of great importance and cannot be regarded as absolutely decided. It is possible that under favourable conditions they may alter in type, but there can be no doubt that in almost every instance the highly virulent hæmolytic streptococci are introduced from without.

Since these observations were completed it is interesting to note that Fromme has made a communication on this subject in which he states, that as a result of further investigations, he has repeatedly found hæmolytic streptococci in the lochial discharge of afebrile puerperal women and also in many cases of mild infection. He has therefore proposed a method of distinguishing between the highly virulent hæmolytic streptococci and those possessing little or no infective power, which essentially depends on the variability of their rate of growth in a solution of defibrinated blood. This method, however, is very complicated and cannot be generally adopted.

We must therefore conclude that we do not possess in the hæmolysis of streptococci any absolute indication as to the virulence of the organism.

It is remarkable that in the literature of the subject we have not found any reference to the occurrence of hæmolytic staphylococci in the uterine lochia. These organisms were present in almost half of the total number of cases, but in only one instance was any sign of infection observed. This occurred in the form of a superficial endometritis from which recovery speedily ensued.

We desire to state that the bacteriological observations have been carried out in the Public Health Laboratory of the University, through the courtesy of Professor Sheridan Delépine, to whom we express our thanks.

CONCLUSIONS.

(1) In a series of 58 cases in which the lochial secretion was examined between the second and ninth day after delivery, organisms were found to exist in the cervical canal and cavity of the uterus in 80 per cent. of observations.

(2) The organisms were mainly those which have been shown to be present in the vaginal secretion during pregnancy. There is, however, considerable evidence to show that organisms also ascend from without during the early days of the puerperium.

(3) The course of the puerperium was, in the great majority of cases, entirely uninfluenced by the presence of organisms.

(4) Streptococci were cultivated in 20 per cent. of cases, and frequently showed marked power of hæmolysis.

(5) The presence of hæmolytic streptococci in the vaginal or uterine secretion cannot, in itself, be regarded as an indication of the existence of infection.

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ANALYSIS OF CASES SHOWING ORGANISMS PRESENT IN THE UTERINE SECRETION DURING THE PUERPERIUM.

No. of Case.	No. of Child.	Day after delivery on which bacteriological examination was made.	Note as to Vaginal Exam.	Staphylococci.		Streptococci.		Pseudo Bacillus diptheritic.	Other organisms.	Remarks.
				Non-Hæmolytic.	Hæmolytic.	Non-Hæmolytic.	Hæmolytic.	Bacillus coli.	Type.	
1	...	...	...	—	—	—	—	x	x	Normal
2	...	...	...	—	—	—	x	x	x	Normal
3	...	...	...	x	—	—	—	—	—	Normal
4	...	...	...	x	x	—	—	—	—	Acid, Hemorrhage
5	...	...	...	—	x	—	—	—	—	Temp. 102°-6 2nd day
6	...	...	...	x	—	—	—	x	x	Normal
7	...	...	...	x	x	—	—	—	—	Normal
8	...	...	...	x	—	—	—	—	—	Normal
9	...	...	...	x	x	—	—	—	—	Placenta prævia.
10	...	...	...	x	x	—	—	—	—	Normal
11	...	...	...	x	x	—	—	—	—	High Forceps
12	...	...	...	—	—	—	—	—	—	Normal
13	...	...	...	—	x	—	—	—	—	Breech presentation.
14	...	...	...	—	—	—	—	—	—	Forceps to head
15	...	...	...	x	—	—	—	—	—	Normal
16	...	...	...	x	—	—	—	—	—	Breech presentation.
17	...	...	...	x	—	—	—	x	x	Normal delivery
18	...	...	...	—	—	—	—	—	—	Normal
19	...	...	...	—	x	—	—	—	—	Normal
20	...	...	...	—	—	—	—	—	—	Normal
21	...	...	...	—	x	—	—	x	x	Normal
22	...	...	...	—	x	—	—	—	—	Normal
23	...	...	...	—	—	—	—	x	x	Normal
24	...	...	...	—	—	—	—	—	—	Normal
25	...	...	...	—	x	—	—	—	—	Rupture of Perineum.