seen in December, 1883, and March, 1884, with relapse of palpitation and a pulse of 200—215. On this last occasion, while under treatment by convallaria, he died in an attack of convulsions. The heart was large, and its structure presented degenerative changes, but nothing was found which could explain the rapid heart-action.

Several cases have come under my observation in hospital or in consultation of which the course and sequel have not been known to me. In one seen with Mr. Stanley Smith in the course of last year, the patient, a lady, aged 64, died after seventeen days' illness, during which the pulse ranged from 150 to 200, the heart being apparently worn out. In one case I saw the patient, a lady of about 45, almost daily for about three weeks. The pulse was never under 200, usually 240, and there was every reason to believe that the heart was beating at the same rate during the whole of the time. The artery was small, full between the beats, not easily compressible, and the pulsation felt more like a vibration than a beat, and gave the impression of there being little or no onward propulsion of the blood. The heart-sounds were short and equidistant, and reminded me of the puffing of a distant locomotive. There was no opportunity of examining the pulse or heart during sleep, but the sleep was broken, and the feelings attendant on the palpitation were always present. This was a second attack after an interval of some years. I saw her in the first, which lasted about five days, and left her looking old and worn. She survived the second for at least two years, since which time I have not heard of her, but with shattered health.

Another case was brought to me by Dr. Seccombe, in April, 1886. The patient, a gentleman, aged 56, was stout, and had a good colour, had lived freely in all respects, and worked hard. He had been suffering from palpitation night and day for three weeks, sleeping for two hours only, and then restless all night. The pulse was 160, and had the character described in the last case; a trace is here shown. There

was a reduplication of the second sound of the heart, best heard near the apex. The liver and spleen were large. Three weeks later the patient still looked extremely well, and his appetite was good, but he was subject to feelings of suffocation, during which he flushed, and his eyes had an expression of distress; these were brought on by very slight exertion, or by stooping. He refused to consider himself an invalid, and went about much as usual. He could lie in any position, but when on his left side required a pillow under the side. He usually slept till 3 A.M., and then woke up suddenly. The palpitation had never ceased; the pulse was always 160; the heart was not much enlarged, the sounds equidistant, the aortic second having a ringing note at the right second space; slight jugular pulsation was visible on the right side, and the liver was large; crepitation was heard in both lungs posteriorly, as high as the angle of the scapula. In June, when seen again, the palpitation continued, having lasted now three months. He had been out of town, and looked as well as ever, but evidences of stasis in the circulation had made their appearance, the legs had suddenly swollen, he could not lie down, and the liver was extremely large. The pulse was still 160; the heart beats as before—equidistant. Various lines of treatment had been tried without effect, and digitalis seemed to do harm. I have not seen the patient since, but I learn from Dr. Seccombe that he continued to suffer very much until November, when improvement began, and the patient was recently said to be so much better as to wish to resume his official duties. A later account, however, describes him as having had an attack of hemiplegia.

This rapid action of the heart is, so far as I know, unexplained, except by referring it to some obscure neurotic influence. It is met with almost at all ages (Dr. Bristowe's patient appears to have been subject to it from the age of 8, and died of it at 19, and I have seen it in a child of 10) although it is more common after middle life than before; usually there is some apparent exciting cause, such as would put stress upon the heart; over-work and anxiety are the most common, but the predisposition, which is of more consequence, eludes us; sooner or later sudden death is the result.

It is interesting to speculate on the condition of the circulation. Clearly it is not accelerated, and the dropsy in Dr. Bristowe's and Dr. Seccombe's cases show that the tendency is to stasis. The pulse, too, gives one the idea of vibratory alternations of pressure with little on-

ward movement. The question then arises, What is the condition of the left ventricle? Either it does not fill in diastole, or it fails to empty itself on systole. It may be that in some cases it is contracted, and refuses to dilate to receive blood from the auricle, and that in others it is in a state of over-distension; but it seems to me that the former is the more probable condition. I have usually found the heart of the normal size, whereas persistent distension would sooner or later give rise to dilatation. Again, the cardiac impulse is often extremely powerful—I have seen the stethoscope lifted through a woman's stays—and this is inconsistent with over-distension.

It might be asked, again, whether the peripheral arterioles and capillaries played any part in the phenomenon; or the pulmonary circulation? These are questions which I am unable to answer, and it is a satisfaction to me to know that the subject is engaging the attention of Dr. Bristowe.

THE LUMLEIAN LECTURES ON THE PATHOLOGY OF INTRA-UTERINE DEATH.

*Delivered at the Royal College of Physicians of London,
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LECTURE I.

THE subject I have chosen for these lectures is one of great importance, not only in its general aspects, and from a statesman's point of view as influencing the law of population, but it has a special interest for the pathologist and medical practitioner. For the pathologist it is so linked and intertwined with other morbid processes, and the pathological changes observed in the embryo and its appendages are so illustrative of alterations going on elsewhere, that they become in some measure types of deviation from a normal condition in other organs, and furnish aid to further research. For the medical practitioner the question is constantly cropping up, How can intra-uterine death be obviated? The death of a fœtus *in utero*, either in the earlier or in the later periods of utero-gestation, is often regarded by parents as an affliction little less than if the child had died in infancy, and in its results on the mind and body of the mother exposes her to certain serious dangers. The repeated abortions which unhappily occur to some women lead not only to grievous disappointment, but seriously impair the general health. Whatever Malthusian views may be held now or in the future as to the desirability of limiting offspring, either for economical reasons or for the purpose of convenience, there can be no question that, for reasons just given, the investigation of the causes of death *in utero*, with a view to their prevention, is a subject eminently worthy of careful and conscientious study.

The causes of intra-uterine death are many, and the subject covers a large extent of ground. When I first undertook to deliver these lectures, I purposed to go over the whole field of pathological inquiry relating to it, but I soon found that it would be impossible to treat the subject exhaustively, and therefore I must content myself with giving in outline a sketch of its broader dimensions, while I dwell with greater detail on those sections which have more especially excited my interest, or in which I have personally made some investigation.

Many disjointed contributions have been made in various parts of the world; but, so far as I know, no adequate attempt has been made, in this country at least, to systematise the knowledge which has been gained; and the work of many authors appears in separate fragments, appearing at long intervals of time, and scattered over a wide area of medical literature. In saying this, I do not undervalue the excellent summaries which are given in such modern works as Barnes's, Playfair's, Lusk's, Tarnier and Budin's, and Spiegelberg's *Systems of Midwifery*—nor the more elaborate sections on intra-uterine pathology to be found in Charpentier's *Traité d'Accouchements*, to which I am indebted for many references.

In the limited field of Placental Pathology, we have several valuable and more or less systematic treatises, among which I may mention

Simpson's, Charpentier's, Bustamente's, Verdier's, and Whittaker's; and, besides, we have the well known contributions, illustrating special diseases of the placenta, from the pens of Robin, Virchow, Hyrtl, Hegar, Rokitsky, Ercolani, and others.

It is obvious that a general treatise on Obstetric Medicine can scarcely find room for a full discussion of all that has been done in this branch of pathology; and, in reference to the special treatises or monographs on placental disease, it may be said that some of them, at least, are out of date. Like all other branches of morbid anatomy, the investigation of diseases in the placenta has made in recent years considerable progress, and opinions and views formerly held in reference to the nature of some of the alterations observed are now regarded as untenable.

Besides examining many fresh specimens, I have gone carefully over the preparations bearing on the causes of intra-uterine death in all the London museums and some of those on the Continent, and it has been an interesting study, in inspecting these preparations, to compare them with the various pathological views which have been expressed by authorities, both in this country and abroad.

I may state at the outset that the complex and intricate anatomical structure and the alterations associated with the rapid development of the contents of the gravid uterus, even in the normal state, render all investigation very difficult. When pregnancy goes its natural course, and development follows its normal progress, the changes which take place are incessant and varying. From the time at which the decidua is first formed in the interior of the uterus, to become the outermost of the foetal membranes, to the formation of the fully-grown placenta, there is no pause or cessation in the active changes which characterise the process of growth. The cells and fibres which build up the tissues day by day undergo progressive change, and the vessels equally undergo modification in size, form, character, and in their relation to surrounding parts. The vegetative process is, indeed, so active that if any derangement occurs, either from accident or disease, the morbid change thus initiated is, or may be, impressed with the same activity, and rapid degeneration takes place, or abnormal growths are produced with surprising quickness.

It can scarcely be a matter of surprise, therefore, that pathological researches into these unstable and ever-changing structures should be beset with difficulties, and that equally conscientious and accurate observers hold different views concerning the nature of some of the pathological results hereafter to be described. The earlier the period of gestation, the greater apparently is the difficulty of pursuing investigations. Then all the tissues are so fragile and delicate that if specimens are procurable their efficient injection is well nigh impossible, and they are likely to be so contused and broken that their true condition is not easily determined. Notwithstanding all the difficulties, researches have been attempted by very competent observers at every period of pregnancy, and the accumulated results so recorded may to a certain extent be formulated, and some at least of the pathological conditions be thoroughly understood.

Many of the causes which either remotely or directly bring about intra-uterine death are very difficult to trace, and some are so subtle in their influence as to be impossible to detect. Thus the child dies *in utero* with some women in successive pregnancies, and without any clearly assignable cause. The "habit of aborting" has been spoken of, as though it were independent of disease. It is not infrequent to hear of women apparently healthy aborting or losing their children in the later months of gestation ten, twelve, or thirteen successive times. Charpentier mentions the case of a woman who had no living child until the eighteenth pregnancy, and this was born at eight months. Both parents were apparently healthy.

Some women are so prone to miscarriage at any period of gestation that the slightest imprudence seems to be enough to endanger the existence of pregnancy, and lead to a detachment of the ovum.

This is in marked contrast to other and apparently not healthier women, who will bear an extraordinary amount of violence or injury without disturbance to pregnancy. Mauriceau¹ relates the case of a woman in the seventh month of pregnancy, who fell from the window of a house, and broke her arm, dislocated her wrist, and, besides, received extensive bruises in various parts of her body, without bringing on labour. Dr. Henry Davies saw a pregnant woman, who, in throwing water out of a window, lost her balance, and fell into the street, breaking both thighs, but she recovered without aborting. Dupuytren has put on record the case of a woman who had severe traumatic tetanus during pregnancy, and who nevertheless went to her full time. M. Brillaud Laujardière relates the case of a peasant who took his wife, while pregnant, behind him on horseback, and started off at full gallop, with the object of bringing on abortion. After shaking

her thoroughly in this way, he dropped her suddenly on the ground without stopping. This treatment he repeated twice without success.² I have on more than one occasion failed to bring on abortion when extreme peril to a woman called for this interference, by passing the sound deep into the uterine cavity, and stirring up its contents; and one case is on record in which an intra-uterine pessary was unwittingly introduced into the womb of a pregnant woman, and was worn for some time without provoking abortion.

The frequency of embryonic death in the earlier stages of gestation is approximately shown by the tables of Whitehead.³ These were taken from the records of the Manchester Lying-in Hospital, and give an estimate so far as it relates to women of the poorer classes. Whitehead interrogated 2,000 pregnant women, whose average age was a fraction below 30 years, and he found the sum of their pregnancies had been 8,681, or 4.34 for each; of which about one in seven had terminated abortively. Seven hundred and forty-seven women had aborted once at least, some oftener; their average age was 32.08 years; the number of their pregnancies was 4,775; that of their abortions 1,222, or 1.63 for each person.

These figures, however, do not accurately represent the frequency of abortion throughout the whole child-bearing period, and a considerable proportion of the women were pregnant for the first time. In any case, they only afford a calculation of the average number of abortions in the first half of the reproductive period; and inasmuch as abortion is alleged to be more frequent in the latter half of the child-bearing period, it is probably much below the average of the whole. This is rendered the more probable by some further statistics of Dr. Whitehead, which he nevertheless admits are too limited to warrant a general conclusion. Of sixty-four women who were living in wedlock until after the final menstrual crisis, only eight had escaped having an unsuccessful pregnancy, the percentage of those who had aborted being eighty-seven.

Hegar⁴ reckons that there is about one abortion to every eight or ten full-time deliveries.

Quite recently I attempted to draw up some tables on the basis of 1,000 cases concerning which I possessed notes of private patients. It seemed to me that as Whitehead's figures were taken exclusively from the poorer classes in a manufacturing town where, according to his account, they were exposed to many privations, and to causes which deteriorate general health, there might be some difference as to the proclivity of abortion in the well-to-do classes. Unfortunately I found that, so far as many of the cases were concerned, the accounts of miscarriage were so untrustworthy or so indistinct as to be valueless. A large number of women had expressed themselves as having had "many" or "several" abortions, and some had persuaded themselves that miscarriage had occurred when there was no satisfactory evidence that pregnancy had occurred at all. I took therefore the figures representing 400 patients in whom the evidence was distinct and unequivocal. All the women had reached at least their 40th year, and hence the history included for most of them the whole of the childbearing period of life.

The results were as follows: 400 women had been pregnant 2,325 times. Of these, pregnancy had resulted in living children 1,783 times, and there had been 542 abortions. The proportion of abortions to children was therefore 30.40 per cent., or about 1 in 3, while the proportion of abortions to pregnancies was 23.32, or about 1 in 4. The number of women who had borne children but had never suffered abortion was 152 in the 400, or 38 per cent., while the number of women who had borne no living child and only had abortions was 27, or 6.75 per cent. The sum of the pregnancies in 400 women being therefore 2,325, or 5.81 for each, and the sum of the abortions being 524, it was 1.35 for each.

It will be seen that the proportion of abortions to full-time pregnancies is considerably higher than Hegar's computation. The proportion approximates more closely to Dr. Whitehead's figures; but there is a larger average of abortions, as the calculation embraces a longer portion of the reproductive period; and there is another notable difference, which may, perhaps, be put down to easier circumstances and exemption from bodily toil, namely, that if a comparison is made with Dr. Whitehead's limited data, concerning those women who had passed the menstrual epoch, it will be remarked that while among the poor of the manufacturing town as many as 87 per cent. had incurred abortion, only 62 per cent. of the women in better circumstances had suffered in this way.

Granville, in his work on *Abortion*, states that, of 400 women, 128 of them had miscarried, and among them there had been 305 abor-

¹ See Tyler Smith, *Manual of Obstet.*, 1858.

² See T. Gallard, *De l'avortement, etc., au point de vue méd.-lég.*

³ *Abortion and Sterility*, 1847.

⁴ *Monat. für Geburt.*, Band xxi, Sup.

tions. Bland⁵ computed that, out of 515 mothers, 147 of them had miscarried. Dr. Tyler Smith, writing on this subject in 1858, remarks that, as, according to the last census, the married female population in England and Wales between the ages of 15 and 55 amounted to 2,553,894, the loss of fetal life based on Dr. Whitehead's or any other calculation must be enormous.

TABLE I.—Analysis of number of Women who had and had not Aborted.

	Women below 30 years of age (Whitehead).		Women over 40 years of age (Priestley).	
	Number.	Percentage of Whole.	Number.	Percentage of Whole.
Women who had not aborted . . .	1,253	62.65	152	38.00
Women who had aborted	747	37.35	249	62.00
Total number of women under observation	2,000	100.00	400	100.00
Women who only aborted—that is, who had borne no living child. . .	—	—	27	6.75

Table I illustrates the point that whereas among the younger women the proportion who aborted was about 1 in 3—that is, one aborted to two who did not—among the older women the proportion was almost exactly reversed, and two aborted to one who did not.

TABLE II.—Analysis of Pregnancies in reference to Abortions and to Fecundity.

	2,000 Women below 30 years of age (Whitehead).			400 Women over 40 years of age (Priestley).		
	Number.	Percentage of whole.	Number per Woman.	Number.	Percentage of whole.	Number per Woman.
Children	7,459	85.92	3.73	1,783	76.68	4.46
Abortions	1,222	14.08	0.61	542	23.32	1.35
Total Pregnancies	8,681	100.00	4.34	2,325	100.00	5.81

Table II shows that the older period is more productive of pregnancies than the younger in the proportion of 5.81 to 4.34 (or 4 to 3); but that the percentage of them terminating in abortions is also much greater in the older period than in the younger (23.32 against 14.08). Table III illustrates the last point in another manner.

TABLE III.—Ratios of Abortions to Pregnancies and Children.

	(Whitehead.)		(Priestley.)	
	Percentage	Being about 1 in	Percentage	Being about 1 in
Ratio of abortions to pregnancies	14.08	7	23.32	4½
Ratio of abortions to children	16.39	6	30.40	3½

As to the particular pregnancies in which abortion most frequently takes place, considerable difference of opinion exists. Dr. Tyler Smith regarded the danger as greater in first pregnancies, particularly among the upper classes, and in those later pregnancies which occur before the cessation of the menses. Whitehead believed that the third and fourth and subsequent pregnancies, and in one or two of the last near the termination of the fruitful period, are most commonly unsuccessful. Schroeder⁶ says that there are 23 multiparæ who abort to 3 primiparæ. I am bound to say that I do not think these computations at all satisfactory or conclusive, inasmuch as various elements are not considered which become important factors in making the calculation. Age has a marked influence on the continuance of pregnancy, be it the first or latest gestation, and the social circumstances in which the woman finds her place in life are not without effect on her successful child-bearing. Thus, women of the better classes incur much more risk of aborting in their first pregnancies than their poorer sisters, from the prevailing fashion of taking long

journeys immediately after marriage. If conception begins then, it is very likely to break down, as the result of the shaking and fatigue incurred, combined with the irritation often set up in the reproductive organs, as the result of the new conditions of life.

The preceding remarks refer more particularly to abortion in the earlier periods of pregnancy.

Concerning the amount and frequency of foetal mortality *in utero* in the later periods of gestation, no very large amount of information is accessible. There are abundant statistics by Collins, MacClintock, Sir James Simpson and others, concerning the number of still-born children resulting from tedious, difficult, and complicated delivery, and with these are included a certain number of children who died antecedent to the supervention of labour. But taking these two together it is obvious that the sum of both forms only a small proportion of the absolute mortality which occurs in the later periods of gestation. Of 16,654 children born in the Dublin Lying-in Hospital, and recorded by Collins,⁷ 1,121 were still-born. Of these still-born children, 801 were either premature or, if at the full time, were putrid, and their deaths were therefore not due to injuries during delivery, or what may be called traumatic causes.

The relative period of utero-gestation in which intra-uterine death most frequently takes place has been variously stated, and for certain reasons cannot be very precisely determined. It is probably very frequent in the form of abortion during the early weeks of pregnancy, and then it may produce so little disturbance in a woman's health as to be scarcely noticed. Among the poor this is certainly the case, and consequently an estimate of its frequency among them is practically impossible. Madame la Chapelle⁸ regarded it as most frequent in the sixth month of utero-gestation. Cazeau⁹ believes abortion to be most frequent in the two or three first months, and Depaul¹⁰ states its greatest frequency to be between two and a half and three and a half months. Jacquemier,¹¹ on the other hand, declares abortion is not less frequent in the sixth month than in the first half of pregnancy. Whitehead's figures show that of 602 cases of abortion, 275 occurred between two and a half and three and a half months, and 147 between three and a half to four and a half months. (See Table.)

TABLE IV.—Showing the Period of Pregnancy at which Abortion occurred in 602 cases, the Relative Number of Still-born and Living Children, and the Number living at the end of a Month after Birth (Whitehead).

Period of Pregnancy at which Abortion occurred.	Number of Births at each Period.	Number still-born.	Number living at Birth.	Number living at the end of a Month after Birth.
2 months	35	—	—	—
3 "	275	—	—	—
4 "	147	—	—	—
5 "	30	—	—	—
6 "	32	24	8	—
7 "	55	38	17	3
8 "	28	23	5	1
Total	602	85	30	4

The stage at which development has arrived, about three to three and a half months, points to a period when, *pro tanto*, abortion may be supposed the more readily to be brought about, and so coincides with Whitehead's statistics just quoted. Then the villi of the chorion have become more concentrated on the decidua serotina, and the young placenta is in progress of formation. There is great increased vascular activity in all the tissues, and yet a certain instability, for the vascular loops projected from the maternal circulation are beginning to surround the foetal villi in a delicate sort of network, and the spaces which intervene between the membranes, so obvious in the earliest weeks, are not yet obliterated. Besides, the union between the membranes and the uterine walls is less stable than later on, and so separation more readily occurs. Hence a greater liability to blood extravasations not only into the layers of the decidua, but also between the several membranes, and more especially between the decidua reflexa and the chorion. From the twelfth to the sixteenth week the phenomenon of "quickening" occurs, and if anything hinders or prevents the ascent of the uterus into the abdomen, abortion is precipitated. Morgagni and Desormeaux¹² are of opinion that abortion is

⁷ *Practical Treatise on Midwifery*, 1835.

⁸ *Pratique des Accouch.*

⁹ *Traité des Accouch.*

¹⁰ *Leçons de Clinique Obst.*

¹¹ *Art. "Avortement," Dict. Encycl.*

¹² *Vide Charpentier*

more frequent with female than with male embryos, but give no statistics, and Cazeau's reason for thinking this may be true is scarcely a sound one, namely, because at term there are 16 boys born to every 15 girls.

Some of the indirect causes which lead to intra-uterine death may be regarded as general rather than specific in their effect. In the case of domestic animals we find abortion, which is not infrequent among them, attributed to a series of indefinite causes, as bad and wet seasons, insufficient and unsuitable food, etc.; and in women, apart from injuries and specific diseases, abortion and death of the fetus during pregnancy are by most authors regarded as brought about by influences which impair the general health and lower vitality, as well as by mental and emotional causes, which are necessarily more potent in the human subject than in the lower animals.

An inquiry into all the circumstances which conduce to, or more directly produce intra-uterine death, extends, therefore, over a wide range of subjects, and embraces a variety of pathological considerations. Not only does it involve a minute inquiry into the several morbid constitutional states in the woman, which may tend to destroy the offspring, but it involves also an inquiry into various deviations of health which may produce a like result on the side of the male parent. It includes various morbid changes which take place in the uterus and its appendages, in the fetal membranes and placenta, and, lastly, in the embryo itself. Various classifications of the causes of intra-uterine death have been made by Spiegelberg, Leopold, Barnes, and others.

I do not propose to follow closely any of these classifications, but shall take first the causes acting through the male parent; then those which act through the intervention of the mother; and, lastly, those which more particularly belong to the fetus itself, although possibly remotely related to both parents.

1. *Causes of Intra-uterine Death referable to the Father.*—Authorities concur in stating that the death of the embryo, after conception, is due, in some cases at least, to defects in the male parent. The fault is, as it were, *ab initio*. Conception takes place, but it is vitiated from the beginning by some alteration in the fecundating fluid. The male parent may be too young or too old to impart the necessary potency to the spermatic fluid, and so the product of conception breaks down and drops like untimely fruit, because it does not possess the necessary amount of vitality to prolong its development. The same thing is seen in plants as in animals. The pollen-cells are sometimes imperfectly developed, as the result of an unhealthy state of the plant; or the pollen may be injured or spoilt, before or during the time it is applied to the pistil, and the result is an imperfectly formed seed or fruit, which never reaches maturity. This is particularly noticeable in diocious plants, and in these experiments can readily be verified. In birds' eggs, again, it is often observed that they cannot be hatched, although no imperfection can be discovered in them. The fault here is probably to be sought in the imperfect impregnation by the male. It seems probable also that some of the forms of monstrosity are due to faulty conditions in the male parent, and these, in a large proportion of cases, lead to abortion or premature fetal death. Debauchery, various diseases and injuries from which men suffer, may so deteriorate the constitution as to impair the procreating power, and so cause abortion in the woman.

Déviillers¹³ points out that procreating power is essentially distinct from that of development; and hence, that a man may possess the power to fertilise, but his whole strength may be expended in this act, and may not extend beyond, so that there is no further development. He further states that the faculty of development is relative. Thus a weak man may impregnate a robust woman, and, by so much as she has strength to impart, the vitality of the germ may be carried on entirely under the influence of the woman. Instances are recorded of women who have aborted in every pregnancy by a first husband, and by a second have gone to the full time. I know of one case where a man, the subject of slight albuminuria, married a young woman apparently in perfect health. They had one child, delicate and fragile, within a year, and the wife aborted successively in three subsequent pregnancies—the husband growing weaker year by year, and eventually dying of uræmia. Since then, I have inquired of several authorities on renal affections, whether they had remarked a special proclivity to abortion in the wives of men who were the subjects of albuminuria, or saccharine diabetes. I have not been able to procure any precise information on the point; but the general outcome of opinion is that, during the progress of these maladies, the vital powers become so exhausted, that sexual power and desire fall into abeyance; and that it is only during the slighter forms of disease that they are likely to continue. My friend, Dr. Frank, of Cannes, has related to

me the case of a diabetic man married to a healthy young woman. Their first child was born alive, the diabetic tendency being slight. After this the wife had a series of abortions, generally in the fourth or fifth month, the diabetic condition in the husband having become more confirmed. Singularly enough, the wife herself eventually died after her husband of albuminuria.

In the *Archiv. Gén. de Méd.*, 1860, is a curious paper by Constantin Paul, in which he shows that lead-poisoning, or saturnine intoxication as it is called, not only injuriously affects the child *in utero* when the mother is the subject of it, but indirectly also when the father is affected. In this way it may lead to the death of the fetus *in utero*, and produce abortion or premature expulsion. In many cases, also, where the child is born alive, the poison may so lower its vitality that it does not long survive its birth. Thus, of 7 women whose husbands suffered from lead-poisoning, there were 39 pregnancies. Out of these there were 11 abortions and 1 dead-born child, and of 27 children born alive 18 died in early infancy, while only 9 survived.

Syphilis.—Perhaps the most potent of all poisons in producing intra-uterine death, at all stages of pregnancy, is the poison of syphilis, and this whether the disease exists in the male or in the female parent. I shall have to speak more fully afterwards of its effects when the woman is the subject of syphilis. Here I propose to say a few words only on its influence on conception in the male. It is readily understood that if a man be affected with syphilis he may communicate the disease directly to a woman *in coitu*, and the usual result will be a local affection, followed by constitutional symptoms, and a general poisoning of all the fountains of life—so much so, indeed, that the fecundated germ, as part of the material system, is blighted from the first. But it is, perhaps, not so readily understood that when a woman has shown no indication of syphilis in her own person she may become impregnated by a spermatic fluid, which carries with it so potent a syphilitic virus that, in its development, it sooner or later kills the product of conception, and this, in its turn, so poisons the maternal blood that the woman eventually becomes tainted with constitutional syphilis. Charpentier, in his *Traité d'Accouchements*, gives a good illustration of this indirect influence of syphilis in the male on conception, and it is but typical of facts accumulated by other observers.

A student of medicine who had contracted syphilis married two years after, being apparently cured, and showing no indication of the affection. His first child was syphilitic, and four other unsuccessful pregnancies followed, the wife, in the mean time, being in good health, and showing no sign of syphilis. Nearly seven years now elapsed without pregnancy, both parents having been carefully treated for syphilis in the interval, when a healthy and vigorous child was born for the first time.

The idea that syphilis could be transmitted directly from the father to the fetus without visibly affecting the mother, was long doubted and combated, but it has been sustained in later days by Trousseau, Depaul, Vidal, Ricord, and by Diday, whose treatise on Syphilis has been translated for the Sydenham Society. In our own country, Professor Harvey¹⁴ and Mr. Jonathan Hutchinson also have adduced very cogent evidence in proof that the mother may be infected by syphilis through the medium of the fetus, and there is every reason to believe that, in many instances where syphilis is, so to speak, latent in the husband, it is not communicated to the wife unless she becomes pregnant by him; in other words, that coitus without conception does not impart the venereal taint to the woman.

It has occurred to me on more than one occasion to treat cases of pregnancy in which there was a strong presumption that the male parent not only begot a syphilitic child, but that the child in its turn infected the mother. For instance, a young man having suffered from both primary and secondary syphilis two years before, and being apparently cured, as all external signs of venereal disease had disappeared, married a healthy wife about his own age. The wife soon became pregnant, and seemed to go on well until the fourth month of gestation, when, about the time of quickening, she began to have great irritation of the vulva, and mucous tubercles made their appearance all over the vulva and round the anus. The throat became affected about the same time, and syphilitic psoriasis made its appearance on the face and chest. Pregnancy went on to the end of the seventh month, when the woman was delivered of a dead child, putrid, and of a placenta infiltrated with nodules of whitish deposit. The mother distinctly stated that she had no sore in the earlier part of her pregnancy, and there was no indication of her being the subject of syphilis until nearly halfway in her gestation.

As remarked by Lancereau,¹⁵ the difficulty in this class of cases is

¹⁴ Vide *On the Fetus in Utero*, by Alex. Harvey, M.D., 1886.

¹⁵ *On Syphilis*, trans. by Sydenham Society, 1868.

¹³ *Dict. M. d. et Chir. Pract.*, etc. (Jaccoud), art. Avort.

to determine when the contamination took place. The father may have had some sore hidden in the urethra and not detected, and the mother may have had some primary lesion which had passed unperceived. In further proof, however, of what has been stated, and of the persistence of syphilis when apparently cured, Vidal¹⁹ refers to three physicians who, believing themselves cured of syphilitic affections, married. The children, the issue of these marriages, presented, a few days after birth, evident traces of syphilitic affection, their mothers never having manifested any suspicious lesion. Lancereau remarks that "this collection of facts furnished by men well informed, and placed in conditions of observation often very different from each other, cannot leave any doubt as to the exclusive action of the father in the inheritance of syphilis."

Baerensprung, the latest authoritative writer on this subject, in his work *Die Hereditäre Syphilis*, cites forty cases occurring in his own experience of hereditary transmission by the father, and although infection in all his cases did not lead to the death of the fetus *in utero*, yet they afford evidence of the point under discussion, namely, the infection of the ovum directly by the male parent. Diday quotes several instances where syphilis was thus transmitted by fathers; and Baerensprung gives fourteen cases in which the father was exempt from any manifestation of syphilis—it was, so to speak, latent—and yet both the mother and child were infected by him. Baerensprung further concludes, from numerous observations made by him, that syphilis in the father is transmissible during the primary and secondary periods only, not in the tertiary period, or, if so, in a much slighter degree.

2. *On the Part of the Mother.*—Before speaking of the specific diseases and local pathological causes which may produce intra-uterine death on the part of the mother, it may be well to glance at the general conditions which conduce to this end. The same general causes which influence sterility, and which have been indicated by Dr. Matthews Duncan,¹⁷ are concerned in a greater or less degree in the production of abortion and premature death of the fetus. Thus constitutional conditions, external agencies which depress the general health, unhealthy habits and occupations, extremes of heat and cold, climate, locality, underfeeding and overfeeding, prematurity or old age; in fact, anything in the mother which tends to deteriorate strength and vigour, must be counted as productive of embryonic death. Some of these influences, as we have seen, are indefinite in their effects, equally in the human subject as in the lower animals. Others are more specific and better defined. Thus, as wild animals in confinement are apt to bring forth abortions, so deviations from normal modes of living, in an insidious way, mar the reproductive faculty in women. Unnatural ways of dressing, particularly tight lacing and the like, late hours, absence of healthy exercise in the open air, confinement in close rooms, all tell in the long run in producing deterioration of the individual; and just as the unhealthy tree will produce monstrous leaves or flowers, or shrivelled or seedless fruit, so we have the analogues in abortions, dead fetuses, sickly children and monstrous products of women. The change from a temperate to a hot, relaxing climate, I have noticed, predisposes women not only to over-profuse and frequent menstruation, but also to abortion. English women going to reside in India are prone to abort. This may in part be due to the luxurious habits of life and the relinquishing of healthy exercise so often superadded to the hot climate. These especially produce sluggishness in the portal circulation and congestion of all the pelvic blood vessels.

So far as I know we have no data by way of enabling us to determine the relative effect of over- or under-feeding on intra-uterine life. That both have an effect is undoubted. We have the analogy shown in the vegetable kingdom, where starved trees and plants produce abortive fruit and seeds. On the other hand, over-maturing or over-nourishment of plants leads to a great growth of tissue, but it conduces to sterility or imperfectly developed fruits. In the poorer class of patients, reported upon by Dr. Whitehead, as we have seen, 87 per cent. had suffered abortion, but in the more affluent class from which I have taken my figures, 62 per cent. only had aborted. But these figures do not throw much light on the effects of over- or under-feeding, as happily it by no means follows that the majority of women who can afford it feed to repletion; nor, on the other hand, are women who become hospital patients, as a rule, so imperfectly fed as seriously to interfere with the processes of nutrition and reproduction. I hold a strong conviction, nevertheless, that over-feeding is more pernicious in its effects on the product of conception than under-feeding. The indulgence in larger quantities of food and stimulating drinks certainly tends to produce sterility, and in like manner it im-

perils the safety of the germ, when once fertilisation has been effected. Besides overloading all the tissues with more material than they can assimilate, and in this way disturbing every function, it more especially disturbs the portal circulation, leads to a congested condition of all the pelvic viscera, and thus favours blood-extravasations into the foetal envelopes, or provokes abnormal uterine conditions. Among authors who have noticed this kind of influence I may mention that Stolz¹⁸ has observed that fat women are often sterile, and if they conceive they are apt to abort. He believes this depends on nutrition taking an abnormal direction, and the nutritive fluids destined for the nutrition of the embryo are thus insufficient for its development.

I have notes of the effects of anæmia, of prematurity and advanced age, of high altitudes, of inter-breeding, of plural births, of too frequent or too rapidly succeeding pregnancies, and of temperament, as influencing pregnancy adversely; but I must not dwell upon these in detail. Anæmia in the mother is a well-recognised cause of foetal death, and large and sudden losses of blood from the maternal circulation may also cause death of the child *in utero*. Convulsions are said to have been produced in the child before its death, when the mother has suffered from much depletion, and syncope in the pregnant woman, long continued, will so suspend the utero-placental circulation as to kill the unborn child.

Of the effect of age in the mother, it may be enough to say that old age is not favourable to the continuance of pregnancy. An old bitch, as Dr. Duncan has told us, often ends her career by producing a dead or premature puppy, and it is a prevalent opinion that the last born of women may either be an abortion or an idiot. It is certainly a fact that the children born of the later pregnancies in women are often not so well developed physically nor mentally, nor so well endowed, as the earlier children; and this disparity is the more marked if in the meantime the mother's health has deteriorated, from disease or vicious habits, such as drinking, etc. It is a noticeable feature in the cases occurring in my own practice which I have analysed, that abortion frequently ends the reproductive faculty in wives; but whether this fact means that the function of the generative apparatus is exhausted *per se*, or that the general powers of the constitution have been so expended on previous child-bearing, or from some other cause, as to preclude the growth and nourishment of further offspring, is not clear. Jacquemier asserts that it is not uncommon to see women abort with the greater facility the nearer they approach to the age when aptitude for fecundation ceases. Depaul¹⁹ does not admit this, but Dr. Duncan's remark on the influence of age on sterility has a direct bearing on this point. Dr. Duncan says: "I know of no cause of sterility or its allies—excessive production, pluriparity, abortion, etc.—that can be compared with age in extent and power."

Broadly, then, general causes contradistinguished from the specific, resolve themselves into any adverse influences which enfeeble and depress the general health of the individual parents, and so impair the procreative power. There seems to be a rule, to which, however, there may be exceptions, that a certain measure of vitality meted out to the individual may be sufficient to maintain and prolong individual life indefinitely, but there must be a superfluity of this vitality to ensure the successful procreation of healthy offspring. In many cases where the death of the embryo arises from obscure or apparently inscrutable causes, there is no doubt that some inherent weakness exists in the body of the parents, which, while it permits conception, affords so small an amount of initial vitality to the germ, that it dies down, out of mere feebleness, and the death of the embryo thus only antedates, as it were, the death of the feeble children in infancy who have just survived long enough to be expelled living from the interior of the womb.

Some writers, as Madame Boivin²⁰ and Madame Lachapelle,²¹ have spoken of epidemics of abortion; but these, when inquired into, have been found to be associated with famines, sieges, and the like. Nägele and Hoffman²² have made some observations on the subject, and during the siege of Paris in 1870-71 abortion was noticed as particularly frequent. "The children born at that time are said to be one and all of a very weak constitution, and are still called '*enfants du siège*.'"²³ Here emotional causes and constant dread of "the Prussians" were no doubt important factors in bringing about the results mentioned; but the utter weakness and want of food suffered by large classes of people must also have told in a marked degree. When epidemics of abortion have been studied in domestic animals, they

¹⁸ *Des Accouchements.*

¹⁹ *Leçons de Clinique Obstét.*

²⁰ *De l'Art des Accouchements.*

²¹ *Pratique des Accouchements.*

²² *Vide Charpentier, Traité Pratique des Accouchements.*

²³ *Pall Mall Gazette*, April 3rd, 1884.

¹⁷ *Traité des Maladies Vénériennes.*

¹⁸ *Lectures on Sterility*, 1884.

have probably been due to some epidemic disease or plague making havoc among them, of which abortion was the secondary effect; or to the presence of ergot either in the grain or on the grasses upon which they had been fed.

Professor Nocard, of the Veterinary School of Alfort, speaks of an epidemic of abortion among cows which is essentially propagated by infection. He says: "L'avortement épizootique semble bien être une maladie microbienne du fœtus et de ses enveloppes, maladie à laquelle la mère reste absolument étrangère."²⁴

Principal Veterinary Surgeon Fleming points out that Franck, of Munich, originally demonstrated that epidemics of abortion in cows depended on the presence of microbes, and he shows that there is abundant evidence of this fact published by observers both in France and Germany.²⁵

Some recent authorities seem to doubt whether ergot in grasses is so frequently a cause of abortion in cows as was supposed. Mr. Harker,²⁶ of the Agricultural College, Cirencester, is among these; and the experiments of Dr. Wright, referred to by Christison, seemed to indicate that ergot had no power of inducing abortion in the lower animals. Nevertheless there is some curious evidence in favour of ergot in grasses producing abortion in cows in *Land and Water* for 1884; and it is elsewhere stated that abortion among cattle in New Zealand was comparatively rare until the introduction of rye-grass, and its becoming affected with ergot, when it caused great losses to the farmers (Fleming).

I have now to speak of the

Direct and Specific Causes in the Mother.—Some acute diseases of a specific kind in the mother have a very marked and direct influence in destroying foetal life. This is especially observed in reference to forms of illness which are attended with pyrexia and increase of temperature, and the danger to the child *in utero* bears a strict relation to the height of the temperature and the amount of systemic disturbance. It may indeed be asserted that, *ceteris paribus*, in proportion to the gravity of the maternal affection so is the danger to her progeny. It is well known how serious is the complication of some febrile affections with the puerperal state, and it seems almost to be the rule that if a pregnant woman is attacked by any of the exanthemata, or in fact by any disease which is attended by pyrexia, and the attack assumes a severe form, death of the fetus is brought about, and is followed by its ultimate expulsion.

Take, for example, small-pox. Serres, quoted by Charpentier, states that in twenty-seven cases which he records, there were twenty-three abortions with twenty-two maternal deaths. This is a sufficient indication of the serious complication small-pox is, when combined with pregnancy. Cazeau²⁷ asserts that there is a great difference in reference to the effects of small-pox both on the pregnancy and on the life of the mother, according as the affection is discrete or "confluent" in its character. When "confluent" small-pox attacks a pregnant woman, it acquires by the fact of pregnancy existing a particular gravity, and abortion is the rule, followed by the death of the mother. Abortion is stated to be most frequent at the suppurating stage, but it may be at any period in the progress of the affection, and in the later periods of pregnancy the child is sometimes expelled living and sometimes dead. Dr. Barnes, who published some cases of pregnancy complicated with small-pox in 1868,²⁸ lays down the proposition that Nature hardly tolerates the concurrent progress of an active disease with pregnancy, and that abortion in these cases may in some sort be regarded as a conservative process. In the three cases he records the children were born alive, and he concludes that the morbid poison of a zymotic disease, aggravated by further blood-poisoning resulting from arrested or disordered secretory function, sets up uterine contraction and so expels the fetus without interfering with its vitality. When the child dies a variety of causes have been assigned for its death, the state of the maternal blood, the infection of the child by the mother, and the increase of the maternal temperature acting injuriously on her child. The fetus once dead, it becomes *ipso facto* a foreign body, and must be expelled.

It has been observed that uterine hæmorrhage is frequent at all stages of pregnancy during the progress of small-pox. This hæmorrhage, according to Spiegelberg and Hervieux,²⁹ is due to hæmorrhagic endometritis, which separates the membranes from the uterus, and in the earlier months leads to abortion, or later to premature labour.

When the child dies in the later months as the result of small-pox,

Brouardel³⁰ regards the death as due to alterations in the maternal blood, which becomes charged with an increased quantity of carbonic acid, and both asphyxiates the child, and brings on premature uterine contraction. Spiegelberg and Charpentier regard the death of the child as due to the increase of maternal temperature incident to the disease, and consider that hæmorrhage, when present, although it may favour uterine expulsion, yet plays only a secondary part in producing foetal death. It seems established that during the suppurating stage of small-pox the temperature is the highest, and then expulsion from the uterus most frequently takes place. Children thus expelled, if born alive, have been observed to die soon after from convulsions. Whether this is due to the disease having been conveyed by the mother to the child can only be surmised. Be this as it may, the mother can no doubt communicate the disease to the infant *in utero*, for children have been born covered with small-pox pustules, generally less advanced than those of the mother. In some cases, however, the mother and child have taken the disease simultaneously, and the pustules have shown the same stage of development in each. Scarletina, measles, erysipelas, diphtheria, typhoid fever, and its congeners, come within the same category as small-pox; each and all are inimical to pregnancy.

Pneumonia.—Of the non-specific forms of disease attended by fever, I may instance pneumonia, which has always a special gravity when complicated by pregnancy. If severe, it almost invariably leads to emptying of the uterus, and then it depends, to some extent at least, upon the date of the pregnancy and the rapidity of its expulsion as to whether the child is born alive. I have on more than one occasion seen abortion produced in the earlier months as the result of a sharp attack of pneumonia or pleuro-pneumonia; and I particularly recollect one case I attended with my friend Dr. Guéneau de Mussy, where, during an attack of pneumonia, a fetus was expelled at the fourth month, of a deep red colour, and the placenta was retained. The complication thus arising was a very serious one, as with the activity of change going on in the body of the patient the retained placenta showed signs of very rapid decomposition going on, and consequent contamination of the maternal blood. The placenta was at length removed, but with great difficulty, on account of the rigid contraction of the uterus, and from that moment there was an amelioration of all the symptoms, and the patient eventually recovered.

The causes of the expulsion and death of the fetus during pneumonia are said by Churchill,³¹ Cazeau, and others, to be the violence of the cough and other attendant symptoms. Grisolle³² considers that the importance of the organs affected, the suddenness of the attack, the intensity of the fever, and the number of sympathetic phenomena, disturb all the bodily functions, and are sufficient to account for the interruption to pregnancy.

Rican³³ and Chatelain³⁴ state that the hindrance to respiration accumulates carbonic acid in the blood, which thus becomes inimical to foetal life, and induces uterine contraction. Ricau, who wrote an interesting thesis on this subject in 1874, collected forty-three cases of pregnancy complicated with pneumonia, and in these the fetus was expelled prematurely in twenty-one cases, or nearly half, eleven of the children being not viable.

Pleurisy may also, if severe, imperil pregnancy in the same way. The feverish state which follows surgical operations frequently leads to abortion and premature labour, if the constitutional state of the mother is seriously disturbed, and this apparently apart from the reflex effect of such minor operations as, for instance, tooth-extraction, which has been followed by abortion. I have repeatedly noticed, after surgical operations on pregnant women, that as soon as there were distinct evidences of the patient going wrong from septic poisoning, uterine disturbance has set in, and if the symptoms increase hæmorrhage begins, which is followed by the expulsion of the embryo. In other cases the emptying of the uterus has been almost the last act of vitality before the death of the patient. Thus, in the case of a woman who, being five months pregnant, had submitted to colotomy for obstruction of the bowels, irritable fever set in after the operation, and she eventually died of blood-poisoning. A few hours before death, the uterus was emptied by a sudden expulsive effort, the child being extruded enveloped in the membranes and placenta entire. There was scarcely any flooding, and the uterus contracted firmly afterwards. It seemed, so to speak, that Nature, finding life was surely departing from the mother, made an effort to save her offspring, the last and final act of her being. Since the child was too premature to be viable, the effort was unavailing.

²⁴ See *Times*, October 13th, 1886.

²⁵ Vide Fleming, *Veterinary Obstetrics*.

²⁶ See *Times*, October, 1886.

²⁷ *Traité des Accouchements*.

²⁸ *Obstet. Trans.*

²⁹ *Gaz. des Hôp.*, 1864.

³⁰ Vide Charpentier.

³¹ *Midwifery*.

³² *Traité de Pathol. Intern.*

³³ *Thèse*, 1884.

³⁴ Vide Charpentier.

The study of the way in which acute diseases, attended with elevated temperature, bring about intra-uterine death and expulsion of the embryo is very interesting.

In 1833, Hohl³⁵ found that the temperature of the mother not only influenced the child, but he found also that it increased the pulse of the fetus, and a diminution of heat made the fetal pulse slower. Huter³⁶ made similar observations in 1861. In six cases he noted a marked increase of the fetal pulsations corresponding to increased frequency of the maternal pulse. Fiedler,³⁷ in 1862, watched two cases of typhus with pregnancy, and he found the pulse of the fetus was increased in frequency like the mother's pulse, and it showed similar morning remissions and evening exacerbations. In the charts he made, he found the fever-curve of the mother's pulse parallel with the frequency of the fetal heart. Kaminsky,³⁸ during an epidemic of typhus and recurring fever in Russia, in 1866, saw 87 cases with pregnancy; 55 were in the first half of gestation, 32 in the second half. As soon as the temperature of a pregnant woman reached 40° C. (104° F.), he observed the child to become disturbed. (1) There was increased activity of its heart, parallel with the increased temperature of the mother. (2) Increased restless movements of the child, the higher the maternal temperature. These signs were marked until the temperature reached 42.5° C. (108° F.), when the movements ceased, and he inferred the child was dead. Danger began at 40° C., and increased with each advance of temperature. The more intense the feverish state of the mother, the surer was the death of the child. The child so killed was not necessarily thrown off immediately, but might be retained for some time. In only two cases in the latter half of pregnancy was uterine hæmorrhage observed, while it was much more frequent in the first half. Similar observations were made by Winckel,³⁹ in 1869; and Löhlein, in a grave case of erysipelas, counted the child's heart-beats at 200 in the minute.

These observations suggested to Runge the idea of making some experiments on the effects of high temperature on the gestation of lower animals, and in the *Archiv. für Gynäkol.* for 1877 his results are published. He placed a series of pregnant rabbits in a well-ventilated box, and raised its temperature in ten minutes to 50° C. (122° F.). The temperature of the animal increased 1° in each five minutes, and the animal died in forty minutes from "heat-stroke"—analogous, I presume, to sun-stroke—if not removed from the box. But the remarkable thing was that the fetuses *in utero* died when a certain temperature was reached which was not sufficient to kill the mother. Runge took the maternal temperature every ten minutes, and killed the animals, with certain precautions, when it reached an elevation varying from 39° to 42° C. On the uterus being opened, the fetuses were found sometimes dead, sometimes living, and their temperature was constantly found some tenths of a degree higher than that of the mother. They were dead every time the temperature rose to 41.5° C. (106.7° F.), and were always alive when the maternal temperature was not higher than 40.5° C., or a little over 104° F. At intermediate temperatures they were sometimes dead, sometimes living. The chief lesions were dilatation of the right ventricle of the heart, which was distended with blood, and retraction of the left ventricle, which was hardened by contraction.

From these experiments Runge concludes that :

1. The temperature of the fetus is habitually higher than that of the mother, and keeps higher when the mother's heat becomes abnormal.
2. That the fetus dies solely from the heat before it becomes fatal to the mother.

3. That the temperature of the mother, if only raised for a short period to 41.5° C., is fatal to the fetus.

In reference to this last deduction, it has been remarked that the danger probably does not at once cease with the reduction of the mother's temperature to normal, for Claude Bernard has seen animals submitted to experiment die several days after being removed safe from a heated stove.

These experiments of Runge's are extremely interesting, and I thought it might be easy to ascertain whether the inference he draws from them is correct, that the animal heat is proportionately higher in the fetus than in the mother, even when no abnormal condition is present. In order to elucidate this point, Mr. Tyrell Brooks, of the Physiological Laboratory in King's College, kindly undertook to make some experiments under my direction. It seemed at first an investigation of no great difficulty, and yet it was less easy than might be supposed. It was necessary, in order to avoid the infliction of pain,

to put the animals under chloroform, and rabbits were found so sensitive to the anæsthetic that their ordinary temperature was speedily altered, and it sank progressively with the depth of the anæsthesia. Nevertheless, by careful management, and by wrapping the body up in warm flannels, the heat was fairly kept up during the continuance of the experiment. Dr. Sclater, of the Zoological Society, was good enough to lend me the very sensitive thermometer which had been used for taking the temperature of the python during incubation at the Zoological Gardens, and in this instrument the column of mercury would run up the entire length of its fine tube in from three to six seconds. This we used in one experiment, but it was found that good sensitive clinical thermometers answered practically very well, and it was necessary to use three at the same moment, so as to make the temperature in the several localities relative. Thus, one was placed in the vagina, the temperature being taken there; afterwards an incision was made into the abdomen and uterus, a thermometer was placed in the cavity of the womb, and another in some part of the body of a fetus, the vaginal thermometer still being retained, and its variations carefully watched. The result showed that in all the experiments where vitality was not so suddenly lowered by the chloroform as seriously to disturb the animal temperature, there was a marked difference between the vaginal, the uterine, and the fetal temperature. Thus, in a large pregnant white rabbit marked with black, the vaginal temperature was 100° F., the uterine temperature 101.4°. Both temperatures were taken simultaneously. A fetus being found, a thermometer was introduced into its mouth, and another into the uterine cavity. The uterine temperature was then 100°, the fetal 100.6°. Ten minutes later a second observation was made on another fetus, three thermometers being used. The uterine temperature was then 99.1°, the fetal (taken in the mouth) 99.3°, the vaginal 98°. In another ten minutes the other cornu of the uterus was opened, and a third observation taken. The uterine temperature was then 99°, the fetal 99.5°, and the vaginal 98.5°. The fetal temperature in this case was taken in the cavity of the peritoneum, which probably accounts for the higher relative temperature. After another ten minutes' interval a fourth fetus was exposed, and the temperatures were—uterine 97.9°, fetal (taken in the mouth) 98.8°, vaginal 97.7°. The natural temperature of the rabbit is about two degrees higher than in the human subject, but it will be observed that the animal heat gradually sank during the experiments, apparently as the result of the anæsthesia. The relative height of the temperatures nevertheless remained the same, the fetal being invariably the highest.

The temperature of the cat is nearly that of the human subject, and in one of these animals near the full period of pregnancy, deeply chloroformed, the vaginal and uterine temperatures being taken simultaneously, the former was found to be 99°, the uterine 100°. Some time was here lost on account of hæmorrhage occurring from divided uterine veins. A fetus at length being secured, the temperature was taken and found to be: vaginal, 98°; uterine, 99.6°; fetal, 99.5°. There was probably some error here, due to the placenta of the fetus being separated from the uterus several minutes before the temperature was taken, for in two other observations on fetuses in the same uterus the temperature was as follows:

Vaginal, 98.2°	Vaginal, 96.5°
Uterine, 98.4°	Uterine, 99°
Fœtal, 99°	Fœtal, 99.3°

These experiments were repeated on other animals, but these details are a fair sample of the whole. In all the uterine temperature was relatively higher than that of other parts of the pregnant animal, and in all, except in one instance, where a shock was given to the vitality of the fetus, the fetal temperature was higher, sometimes considerably higher than the general temperature of the body of the mother. Further, the temperature of the fetus, although not sinking so fast as the maternal temperature, was manifestly influenced by it, declining at a somewhat less rapid rate, but still keeping a sort of relation to the heat of the mother's body.

All these facts collectively are very instructive. It follows that if the temperature of the mother is raised, either as the result of experiment or from diseased action, the temperature of the fetus will rise with it, and inasmuch as this is higher from the first, the fetus will arrive at the heat indicating danger before the mother does; and Winckel indeed remarks that it is probable the fetal warmth rises in quicker proportion in the fetus, because the liquor amnii, part of whose function it is to conduct heat from the fetal body, becomes itself overheated and so ceases to control the fetal temperature. I may mention that I have taken the temperature of the fetus while *in utero* in a case of breech presentation. In this case I put a clinical thermometer into the fetal anus, and the temperature then was five-tenths of a degree higher than in the maternal vagina. Gusserow has shown that

³⁵ *Die Geburtshülfe Explor.* 1833.

³⁶ *Monatsschr. für Geburtsk.* 1861.

³⁷ *Archiv. der Heilkunde.* 1862.

³⁸ *Moskauer Med. Zeit.* 1866.

³⁹ *Pathol. der Geburt.* 1869.

the temperature of the foetus immediately after birth is constantly from 0.1° to 0.3° above that of the uterus and vagina.

It seems to be well known to physiologists that wherever great activity of function is going on in animal bodies there will be an increase of temperature. Professor Gerald Yeo informs me that there is increase of heat in the liver, beyond what is observed in other parts of the body, and this is most notable after a meal. The observations of M. Valencienne and Dr. Sclater have demonstrated that a considerable increase of heat is generated in the body of the female python during incubation; but the remarkable thing, and one perhaps which has not been sufficiently appreciated, is that regions of the body in mammiferous animals, where rapid nutrition or change are going on, may have a considerably higher temperature than the rest of the body, and it is just possible that some suggestions for treatment by way of controlling local temperature may arise out of this.

The next point of inquiry or conjecture is, how does increase of heat destroy the foetus *in utero*? In other words, what is the *modus operandi*? Is it from "heat-stroke," somewhat analogous to "sun-stroke," which, according to Runge, killed the adult rabbits when long exposed to high temperature. Houliet⁴⁰ has stated his belief that death is owing to degeneration of the myocardium. The heart at first becomes excited, then paralysed, and there is coagulation of the myosin. The same author states that in a child born of an eclamptic mother with a temperature of 40°C . at the moment of birth, he found granular degeneration of the cardiac vessels. I am, however, informed that it would require a temperature of 60°C . to coagulate myosin, so that some other explanation must be sought for. From the highly congested appearance of the foetus expelled during the continuance of high fever temperature in the mother, it is obvious, that as the result of the heat, all the capillary blood vessels become overcharged, and a state of hyperæmia is engendered which is quite incompatible with foetal life. Not only is the cutaneous surface of a deep livid colour from distension of the capillaries, but every tissue in the interior of the foetal body is gorged with blood, as in a state of active inflammation. These changes of themselves one may imagine would be sufficient to account for the movements of the foetus first becoming restless, then convulsive, and at last ceasing altogether. On microscopic examination of the congested tissues, I found the capillaries distended with blood, and the globules heaped up in confused masses, with here and there indications of rupture, and more or less of extravascular exudation.

It will be observed that, while the heat-theory affords a tolerably clear explanation of the cause of death *in utero* during the progress of diseases in which the maternal temperature is raised largely above the normal standard, it yet furnishes no adequate explanation of those cases in which the foetus is frequently and rapidly expelled from the uterus, alive or dead, during the progress of some of these affections. It is true that the child may die from increased internal temperature, and be long retained after its death. It is also true that, in a large number of instances, the foetus is expelled alive; and if sufficiently developed it may continue to live, although it is prone to succumb after birth, even if near the full time.

The explanation of this tendency to forcible uterine contraction is, I take it, to be found in some observations of Brown-Séquard⁴¹ in 1851. This distinguished physiologist showed that the circulation of dark venous blood—that is, blood imperfectly aerated, or from any cause rendered impure and charged with carbonic acid—had a remarkable effect in stimulating the nervous centres and contractile tissues. He made the deduction that oxygen gave and created contractile force; carbonic acid brought contraction into play. These elements, properly correlated and balanced, are in consonance with the continuance of pregnancy. If blood accumulates in the uterine sinuses, not only does distension act in promoting rhythmical contraction, but the carbonic acid of the blood is still more potent in bringing the uterine muscles into play, and so stagnation is prevented. Anything, therefore, which disturbs the systemic circulation, and more especially anything which prevents or retards the proper aeration of the maternal blood, acts as a direct incentive to uterine action; and if this passes beyond the normal physiological limits, abortion or premature labour is the result.

In pneumonia, in the eruptive fevers, in other diseases or injuries attended with febrile excitement, we have this pathological state directly induced, and hence the liability to emptying of the uterus. The same explanation would apply to asphyxia in the mother. It is recorded⁴² that, during a *razzia* in Algeria, conducted by the Duc de Malakoff, hundreds of Arab women were suffocated in the caverns of

Dahra, and it was found that many of those pregnant had aborted. The same thing occurred in a similar exploit under the celebrated Chevalier Bayard. In some forms of heart-disease, and in some of the other acute or chronic lesions of the circulation, similar pathological conditions may be produced, and so lead to premature uterine action.

There is still another complication occurring in connection with pregnancy, and said to be attended with remarkable increase of heat, which can scarcely be passed over without notice.

In eclampsia, or puerperal convulsions, it is well known that great peril attends the child. If labour and rapid delivery follow the super-vention of convulsions towards the end of pregnancy, the child may survive, but convulsions are almost uniformly fatal to it if labour does not come on. The child is then expelled later, marked by such changes as are peculiar to the longer or shorter time it is retained *in utero*. The nearer the attack of convulsions comes on to the completion of pregnancy, the greater the chance of its preservation, and the chance is the greater if convulsion comes on for the first time during labour, and the case admits of speedy delivery. The cause of foetal death in eclampsia has been attributed to the convulsions interfering with the hæmæstasis of the blood—that is, producing asphyxia.

Braun⁴³, of Vienna, believes uræmia to be the cause of death. The foetus is impressed by the first or second access, and almost always dies after a certain number of attacks. If the mother dies, and the child is removed by the Cesarean section, it is always dead. It is asserted that if the child is per chance born alive, much urea is found coming from the cord; if dead, much carbonate of ammonia is found in the blood. It is further asserted that uræmia may kill the child without eclampsia having come on, and that the children of eclamptic patients are often albuminuric.

In seeking for the explanation of foetal death in puerperal convulsions, Winckel⁴⁴ claims that he first pointed out a remarkable rise of temperature in the mother during the paroxysms. The French dispute his priority, and Charpentier, in controverting his claim, makes an attack upon him which shows that the anti-German feeling has permeated even the realm of science. He endeavours to show that Kien, a pupil of Hirtz, made the first serious researches with the thermometer in eclampsia, and after him Bourneville,⁴⁵ a pupil of Charcot's, who, in 1871 and 1875, made observations on thirteen patients, to which he adds four of Budin. Bourneville concludes that the temperature increases from the beginning of the attacks to the end; it may run up to 43°C . or 109.4°F . In the intervals, a high temperature is maintained, and this is slightly increased with each paroxysm. If the case terminates fatally to the mother, the temperature goes on increasing until death, but, if better symptoms supervene, the temperature declines.

In view of the researches of Runge, therefore, it may be that foetal death in eclampsia is due to such elevation of temperature in the mother's body as is incompatible with the safety of the child. When the temperature does not reach so high a standard, the death must be attributed to uterine contraction producing imperfect aeration of the blood, or vitiation of the blood from uræmic poison.

It is stated that there is a very marked contrast in the temperature of the patients suffering from puerperal eclampsia and those stricken with convulsions the result of general uræmia, and it is asserted that the thermometer indicates a positive diagnosis between the two; for while in eclampsia the temperature always rises, and may run up, indeed, to 43°C ., in uræmic convulsions and coma—and equally in men and women—the temperature invariably falls progressively, and sometimes falls to 30°C . With some exceptions, it falls until death. The authors mentioned, therefore, conclude that eclampsia is not from uræmia, because the temperature is different in the two cases.

There are some diseases of women attended by abnormal increase of temperature, in which the tendency to abortion and premature labour is greater than in healthy women, and yet in which the higher temperature probably plays but an unimportant part in contributing to foetal death.

In Phthisis there is an admitted fertility among women which is almost abnormal, and the tendency to abortion and premature delivery, although not very striking, is yet greater than among healthy women. We are indebted for much precise information on this subject to these published in France by M. Ortega and M. Gaulard.

I must pass with mere mention diabetes, jaundice, heart-disease, and malignant cholera, simply remarking that these and allied morbid conditions may destroy the product of conception by poisoning it *in*

⁴⁰ See Charpentier, *Traité*, etc.

⁴¹ See *Journal de Phys.*

⁴² Tyler Smith, *Man. of Obstet.*

⁴³ *Lehrbuch der Gynæc.*

⁴⁴ *Berichte und Studien.*

⁴⁵ *Archiv. de Toccol.*, 1875.

utero, or by inducing uterine contraction and premature expulsion. These and allied morbid conditions, if they stop short of producing expulsive efforts, may yet produce congestion and possible extravasation of blood in the placenta. They may thus so injure the nutritive and depurative functions of that organ as to compromise the life of the foetus. These congestions and extravasations in moderate degree may interrupt the utero-placental circulation, and destroy the child without leading to its immediate expulsion; but if more intense and rapid, so as to produce at once irritation of the uterine walls as well as disturbance in the placenta, they excite the uterus suddenly to contract, and delivery speedily follows.

I have spoken of certain morbid poisons acting upon the product of conception through the paternal organism. There are some specific poisons, both inorganic and organic, which, getting an entrance into the maternal blood, act more directly on the contents of the gravid uterus, and either kill the child or lead to its premature expulsion before it is capable of maintaining a separate existence.

I have no time to go into the proofs, which are now ample enough, that poisons can be transmitted through the maternal organism and destroy the product of conception, sometimes, indeed, without much perceptible effect on the mother, so far as the specific poison is concerned. Thus lead-poisoning acts deleteriously on pregnancy in the female as well as on the male. Other poisons have been named, both organic and inorganic—arsenic, mercury, savin, and the like.

The morbid organic poison which is probably the most pernicious, and has the most extended adverse influence on foetal life, is syphilis. I have spoken of the effects when transmitted by the father. Its power in destroying foetal and infantile life, when the mother is the subject of venereal disease, is now almost universally admitted by authors, both in this country and abroad.

Syphilis was mentioned in this relation as long ago as Astruc. And yet it is curious to note, considering the unanimity of opinion about it at the present time, how comparatively recent is the recognition of its lethal power in this respect. Dr. Whitehead was one of the earliest and best writers on abortion in this country, and on turning to his book, published in 1847, I find the following: "The complaint in question was not suspected of being so frequent a cause of abortion as it has since appeared to be, nor did it until very recently engage a particular share of attention. I remember it was the opinion of my lamented and eminent friend Mr. Fawcington, that abortion in a great proportion of cases was occasioned by a condition induced by the venereal taint." And he goes on to express his entire confidence in the accuracy of his friend's observation. Since then the evidence has so accumulated concerning the influence of syphilis in destroying children *in utero*, both early and late in gestation, as to be overwhelming. For example, in some comparatively limited statistics of Mr. Scott Battams, given in the *Lancet* for 1883, 10 syphilitic mothers produced 40 children, of whom 12 had died, and they had suffered among them 20 abortions, or half as many as they had borne children. Of 53 syphilitic women observed by Fournier⁴⁶, 28 only went to the full time, and there were 25 abortions or premature deliveries. Of 390 pregnancies with syphilis recorded by Lepileur, 249 went to term, and there were 141 abortions or premature births. In the larger tables collected by Charpentier⁴⁷ from the data of Fournier, Lepileur, Weber, and others, it appears that of 657 pregnancies in syphilitic women there were 426 deliveries at term, many of the children, however, being still-born, and there were 231 abortions, or 28.4 per cent. of the whole. Evidence, indeed, might be multiplied almost indefinitely, and, viewed in this respect alone, the ravages of syphilis appear most deplorable.⁴⁸

The non-professional public can, of course, know little of the insidious and noxious influence of syphilis so manifested, and of the way in which it affects large numbers of women and children, innocent of any trace of immorality. Did they fully realise the disastrous consequences of permitting a diffusion of this loathsome disease without let or hindrance, they would bestir themselves to adopt preventive measures against its propagation, and until such a time as it could be absolutely prevented would be glad to aid partial projects for its diminution, even when such projects seem in some degree to clash with the generally understood idea of the liberty of the subject, or run counter to cherished notions on what has been termed the "State regulation of vice."

⁴⁶ *Syphilis*.

⁴⁷ *Loc. cit.*

⁴⁸ It is, besides, abundantly proved that syphilitic disease may not only destroy the embryo at all stages of its development *in utero*, but also that if the child is born at full term it may show evident traces of venereal taint at its birth, or if apparently healthy when born of syphilitic parents, it will develop infantile syphilis before many weeks or months of its life have elapsed, and either die or remain a miserable object afterwards.

In women who are the subjects of syphilis, abortions often succeed each other in frequent repetition, and with a persistency belonging to no other cause. It has, moreover, been often remarked that when there are no external indications of maternal syphilis, the succession of abortions, or of dead children in more advanced pregnancy, is traceable to a latent form of the disease which manifests itself in this fashion. Fournier especially dwells on this point, and holds that women who are most deeply and viscerally affected are most liable to abortion, although it may happen to those affected in all degrees, even the most lightly. Confirmatory evidence of Fournier's position is deduced by the effect of anti-syphilitic treatment, which very frequently succeeds in stopping the tendency to abortion. Some cases of abortion, without apparently syphilitic symptoms in the mother, are no doubt due to the transmission of venereal taint from the father.

The effect of syphilis has been now so carefully studied that some general laws have been formulated concerning its effects on human gestation. Thus it has been proved (1) that if a woman has syphilis before conception she is much more predisposed to abortion than a woman taking the disease after conception; (2) if conception and syphilis commence together, abortion or premature labour with a dead child are the rule, but treatment is more potent in preventing them; (3) syphilis acquired after the mid-period of pregnancy has less influence on the child, and it may escape altogether.

Perhaps the worst feature in the relation between syphilis and pregnancy is its persistent and extended influence. It is impossible to say when the effect of the poison will be expended; and long after all outward signs of the disease have vanished in the bodies of both parents, the tendency to abortion may remain, or there may still be the production of dead children, or of feeble emaciated children if born alive, showing external evidences of venereal taint; or, lastly, in the absence of these, so small an amount of vitality that the children are reared with difficulty.

One of the ways in which syphilis brings about intra-uterine death, as will be seen later, is by producing disease in the foetal appendages. There can be no doubt that the venereal poison is transmitted to the embryo through the maternal blood, and thus it may affect all the tissues in the gravid womb, sometimes manifesting itself in one locality, sometimes in another. Thus it may attack the body of the foetus or its placenta and membranes. We have both the direct evidence of such transmission, and also the collateral evidence derived from the transmission of other agents through the maternal circulation.

Belonging to this section of the subject as recognised causes, under certain conditions, of intra-uterine death, are local derangements of the generative organs in women; for example, uterine congestion and inflammation in its several varieties; leucorrhoea, dwelt upon by Whitehead and others; various displacements and special diseases of the uterus, acute and chronic; affections of the uterine appendages and neighbouring pelvic structures; besides these, pelvic adhesions, noticed by Madame Boivin⁴⁹ as causing abortion, direct irritation, or injuries of the uterus and vagina, oxytocic medicines, etc. These I must not stop to discuss; they are mentioned in this relation in most modern works on obstetric medicine. With your permission I will conclude with a few words on the reflex causes of abortion.

Reflex Causes.—The late Dr. Tyler Smith⁵⁰ drew attention to the frequency of reflex or excito-motor causes of abortion, and particularly to the effect of irritation of the mammary nerves. He averred that he had seen abortion produced during lactation from the irritation of constant suckling. He inferred that it was not mere weakness or exhaustion producing the effect, because the mammary secretion may cease on the occurrence of impregnation, but a plentiful supply of milk returns after the occurrence of abortion. It is well known that the uterus may be made to contract after delivery by putting the child to the breast; and Professor Scanzoni, in view of these facts, has proposed irritation of the mammae as one of the methods of inducing premature labour. The results of the method have proved too uncertain for general adoption. But reflex motor actions originating in other organs besides the mammae are acknowledged to have the effect of inducing abortion in some cases. Thus irritation of the trifacial nerve during the cutting of a wisdom-tooth, or from tooth-ache, are said to have this effect. I have seen abortion brought on by the extraction of a tooth, but I do not think this peculiar to dental operations, as I have seen it follow other minor surgical proceedings, apparently from the nerve-disturbance they produced, as there was no marked increase of temperature.

Quite recently I was confronted, not for the first time, with the question, "Is it desirable to remove the breast by surgical operation

⁴⁹ *Recherches sur une des Causes de l'Avortement*, 1828.

⁵⁰ *Loc. cit.*

during pregnancy?" The patient was about thirty years of age, six months pregnant, and she had a tumour, believed to be malignant, in the right breast. It had somewhat rapidly developed, and the axillary glands were enlarged. The whole aspect of the patient was unhealthy, if not cachectic, and it was deemed advisable to remove the breast as speedily as practicable. The eminent surgeons consulted in the case hesitated to operate during the continuance of pregnancy, as one of them at least had recollection of similar cases ending disastrously, abortion coming on after the operation, and the patient dying as the result of the double injury. From my own experience, I was able to say that abortion seemed chiefly to have been provoked under such circumstances when the breast wound was going wrong, and there were evidences of constitutional irritative fever. In fact, that although there is such well known and intimate sympathy between the nerves of the breast and the uterus, the abortion was less due to reflex action than to elevation of maternal temperature associated with septicæmia. In these days of antiseptic surgery, where healing by the first intention is the rule, removal of the breast and other similar operations may certainly be undertaken with less risk of abortion than formerly. In view, nevertheless, of the fact that abortion sometimes comes on from the reflex effect of all operations, however trivial in character, it is well to abstain from surgical proceedings during pregnancy, unless urgently required. In the case I have referred to it was at one time proposed to bring on premature labour, and to operate on the breast as soon as the puerperal period was passed. The proposal was eventually abandoned, because some time must elapse before the child would be viable, and the disease in the breast was extending. Consequently the operation was performed at once, and the patient made a good recovery without aborting.⁵¹

In undertaking any operation upon a pregnant woman it is important to recollect that the uterus is more irritable at times which correspond to the catamenial periods. It is well, therefore, to avoid these periods.

Intense and persistent gastric irritation has also been known to bring on abortion, and this notwithstanding the fact that a pregnant woman will sometimes be brought almost to death's door, by continued nausea and vomiting, without provoking any sign of uterine contraction. Vesical, renal, and rectal irritation may act in like manner. Lastly, ovarian irritation undoubtedly favours the occurrence of abortion, and consequently there has been observed a marked tendency to abortion at times corresponding to the catamenial periods, more especially in women who have been the subjects of ovarian dysmenorrhœa.

Nearly akin to excito-motor causes are the effects of mental emotion on pregnant women. There is, no doubt, greatly increased nervous tension in all pregnant women. Fright, anxiety, a sudden impression made upon the mind or body, may not only initiate uterine contraction at any period of pregnancy, but there is reason to believe that a sudden mental shock may at once kill the embryo or child, even if it be retained some time afterwards. Repeatedly it has occurred to me, as to others in practice, to have patients dating the exact time of their child's death *in utero* to some alarm or shocking occurrence which has profoundly affected the whole nervous system. The immediate effect described was, first, violent perturbation and undue active movement of the child for a brief interval, followed by cessation of fetal movement, and absolute quiescence in the future. In a few rare instances the woman has been mistaken in supposing her child to be dead after a shock or fright she has experienced, but in a large number of cases the relation between the cause and the effect has been too clear to be accounted for by mere coincidence, and the child has sooner or later been expelled dead, possibly both dead and putrid.

It is not uncommon thing for a woman in early pregnancy, on the receipt of bad news which much perturbs her, to be seized with uterine hæmorrhage, which may eventuate in abortion. Condemned women prior to execution have been known to abort beforehand, and, under the influence of terror and pain, martyred women in former days are said to have aborted at the stake. So potent is mental influence on the stability of pregnancy, that I have had reason to believe the mere dread of miscarriage has in some women been an important factor in bringing it about; and I have known pregnant women who had previously miscarried get into such violent mental agitation as the time approached when they had aborted before, that the event they feared was precipitated, and pregnancy was brought to a premature conclusion.

⁵¹ According to Massot (Schmidts' *Jahrbuch*) and Cohnstein (Volkmann, *Saml. Klin. Vort.*, 1875) operations on the genito-urinary organs are most likely to be followed by abortion; and Spiegelberg says that no operation on pregnant women should be performed at the time of the menstrual epoch, as abortion is more likely to occur then.

ABSTRACTS OF

THE GULSTONIAN LECTURES, ON THE NATURE OF FEVER.

Delivered at the Royal College of Physicians of England, March, 1887.

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LECTURE III.

I HAVE to confess that we know little or nothing as yet of the anatomical course of the thermal nerves of the muscles. The motor trunks would appear to contain the thermogenic fibres—if, indeed, they are not identical with the motor fibres. But as to the course of the anabolic fibres we can only conjecture, and the analogies which we have to guide us are too obscure for me to dwell on here. It has been known from the time of Sir Benjamin Brodie that section of the spinal cord is in some cases followed by a surprising rise of the body temperature. In other instances the temperature falls; and some observers have found that according as the animal is exposed to a warmer or cooler medium, according as it is wrapped up or naked, its temperature will ultimately rise high or sink low. Professor Wood has shown how these inconsistencies may be reconciled by measuring the actual heat produced by an animal before and after section. As the result of many rigorous experiments, he is able to state that "section of the spinal cord above the origin of the splanchnic nerves is usually followed by an immediate very decided increase in the amount of heat dissipated from the body, and also by a decided lessening of the amount of heat produced." The vaso-motor tracts being divided in these experiments, it is certain that vaso-motor paralysis has a great deal to do with the increased loss of heat, while the paralysed muscles, being cut off from their regulating nerve-supply, are apt to have their thermogenesis increased or diminished by the high or low temperature of the surrounding medium, much as when they are poisoned with curare. The temperature of the body is thus the resultant of a number of diverse thermal tendencies; and as one or the other is in the ascendant the temperature rises or falls. Successively, higher and higher sections of the cord at length carry us to a level above the highest or dominating vaso-motor centre in the medulla, and not till then do we get results that are fairly uniform and intelligible. If the medulla is divided close to its junction with the pons, the vaso-motor mechanism appears to remain intact. In the dog at least there is generally a rise of temperature; but whether this happens or not, the rate of heat-production is invariably augmented. Heat-loss is also increased, but it seldom keeps pace with the heat production. Moreover, the increased heat-production is not simply transient, it goes on for a long time, and in some instances is greater twenty-four hours after operation than it is at first. Again, when the same region—namely, the part of the medulla which immediately adjoins the pons—is mechanically irritated by a puncture, in several instances a marked temporary fall in the rate of heat production has been observed (Wood), though in others electrical stimulation of the part is said to have been followed by a prompt rise of temperature at least.

These experiments certainly suggest the hypothesis that the region in question is traversed by some of the anabolic or inhibitory fibres. Severance of them is followed by a disturbance of the balance I have called thermogenic tonus; the inhibitory influence being cut off, the excitor influence has full sway. Irritation of the same tract is followed by a temporary diminution of thermogenesis, just as irritation of the vagus tract is followed by a temporary diminution of the contractile activity of the heart.

Professor Wood has gone further in his attempts to trace upwards the inhibitory tract, and appears to have shown that severe injury of certain regions in the cortex or beneath it is, in the dog at least, followed not merely by rise of temperature—that is of secondary importance—but by increased production of heat. This cortical area is just posterior to the crucial sulcus, and corresponds in Hitzig and Ferrier's scheme to the motor region for the muscular masses of the limbs. The experiments in which stimulation rather than destructive injury of this region was attempted are neither numerous nor altogether