LECTURES ON THE EXPERIMENTAL INVESTIGATION OF THE ACTION OF MEDICINES.

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III.—ARTIFICIAL CIRCULATION: INVESTIGATION OF BLOOD-PRESSURE.

Artificial Circulation of Blood.—Circulation of Warm and of Cold Blood.—Fever.—Mode of Conducting Artificial Circulation.—Application of this Method to Pharmacological Investigations.—Schema of the Circulation.—Circulation in the Living Body.—Importance of the Arterial Elasticity.—Arterial Tension or Blood-Pressure.—Oscillations in it produced by the Heart and Respiration.—Causes of Variation in the Blood-Pressure.—Influence of Nerves upon it.—Cardiac Ganglia.—Inhibitory Nerves of Heart.—Quickening Nerves of Heart. Vaso-motor Nerves.—Vaso-inhibitory Nerves.—Action of Counter-irritants.—Tabular View of the Causes of altered Pulse-Rate and Blood-Pressure.—Application of this to Pathology.—Experimental Examination of Blood-Pressure.—Forms of Manometer.—Kymographion.—Mode of Using the Kymographion.—Reduction of the Kymographion Tracings.—Mode of Recording Experiments.—Graphic Method of Representing Experiments.

APPLICATION TO PATHOLOGY.—The brief sketch of the circulation which I have given, will enable you to understand and appreciate the meaning of the changes produced in our circulation by any drug, and to explain the facts we may meet with in the course of an investigation. I may remind you that the alterations in the pulse-rate and blood-pressure which we meet with in disease, as well as those produced by drugs, are due to some one or other of the causes mentioned in the previous table; and whenever you meet with a quick, slow, weak, or irregular pulse, you must try to find out to which of these causes it is due, in order that you may be able to apply scientifically the proper remedy.

EXPERIMENTAL EXAMINATION OF BLOOD-PRESSURE: FORMS OF MANOMETER.—As the life and health of the body and of the organs comprising it depend on the supply of blood to them—and this, as we have already seen, is closely associated with the arterial pressure—the observation of the effects of drugs on it naturally forms one of the most important parts of an investigation into their action. The first to measure the blood-pressure was Hales, who simply connected a glass-tube with an artery, and noted the height to which the blood rose in it. Poiseuille improved upon this method by substituting a bent tube, partially filled with mercury, for the straight tube, and estimating the pressure from the difference in the level of the mercury in the two limbs. A solution of carbonate or bicarbonate of soda was introduced into the tube between the mercury and the blood in order to prevent its coagulation. The bent tube, partly filled with mercury, is called a hæmady-namometer, or, more generally, a manometer. The height of the mercury is read off from a scale fixed behind the tube. Usually both limbs of the tube are of equal diameter, and the blood-pressure is then ascertained by doubling the height of the mercury in one limb above zero and subtracting a fraction, which varies with the specific gravity of the solution of soda used. The height must be doubled, because the mercury descends as much below zero in the one limb as it rises above it in the other; and a fraction of the whole is subtracted for the additional weight of the column of soda solution, which enters one limb as the mercury rises in the other.

A very simple manometer, which will show the mean blood-pressure as well as the maximum and minimum between which it oscillates, may be made by passing two straight glass-tubes about sixteen inches long through the cork or India-rubber stopper of a small wide-mouthed bottle, and fixing behind them a graduated cardboard scale. The lower end of one tube must be nearly closed in the blow-pipe flame, and both pushed down till they almost touch the bottom of the bottle. A third bent tube is inserted into the stopper, reaching only to its under surface, and a piece of India-rubber tubing is attached to its upper end for the purpose of connecting it with the artery. Some mercury is then poured into the bottle, so as to stand a little above the ends of the tubes, and both it and the India-rubber tube are filled with a saturated solution of bicarbonate of soda and connected with the artery. The mercury rises and falls in the open tube with every pulsation; but in the one with the constricted end the resistance to its movement is so great that it can only rise and fall slowly, so that, before its upward oscilla-

tion has had time to show itself, its descent has begun, and *vice versô*. The upward and downward oscillations thus balancing each other, the mean pressure only is shown.

The oscillations in the unconstricted tube are so rapid that it is impossible for the eye to follow them exactly; and this difficulty led Ludwig to conceive the idea of making them register themselves by means of a slender rod swimming on the surface of the mercury, and bearing at its upper end a pen which moved up and down on a piece of paper fixed on a revolving cylinder. The vertical height of the tracing thus produced showed the blood-pressure, while the horizontal distance from one point to another on it indicated the time between them.

This instrument is called a kymographion; and in devising it, Ludwig introduced for the first time into physiology that method of self-registration which is now generally applied to all kinds of vital phenomena, and has already done much to render our knowledge exact. That form of it which is used by Traube and made by Sauerwald of Berlin is shown in fig. 7. It consists of a metal cylinder (*p*) supported

A. Ludwig's Kymographion. *a'*. The manometer. Instead of one simple bent glass tube, it consists of two tubes fixed on a piece of wood, and joined by a piece of metal *b*, which may be unscrewed for cleaning the tubes. *c* is a tube of soft lead, for connecting the manometer with the artery. One end of it is screwed to the manometer, and the other is attached to a stopcock *d*. *d* is a stopcock attached to *c*, and may be connected with the tube *b* in the artery by a piece of India-rubber tubing. It is bored in a T-shape, and is perforated in the centre by an additional perpendicular hole, into which is put a hollow plug *e*. *f* is a flask containing saturated solution of bicarbonate of soda, and connected by India-rubber tubing with *e*. When the clip on the India-rubber tube just above *e* is removed, and the stopcock turned longitudinally, soda solution will flow into *c* as well as out of *d*. By turning it transversely, the

opening towards *c* may be closed, and soda will then only run out through *d*. This is done when we wish to wash out the cannula with soda without altering the level of the mercury in *a*. *g* is a glass pen attached to the top of a glass rod or swimmer, which rests on the surface of the mercury in *a*. *h* is a thread of unspun silk, with a small weight attached to it. It rests against the pen *g*, and keeps it constantly applied to the paper without impeding its movements. *i* is an iron wire, from which the thread *h* is suspended. *j* is the wooden frame bearing the clockwork and revolving cylinder. *k* are three screws to level the frame. *l* is the clockwork. *m* is an upright, and *n* a horizontal bar, which support a pivot *o*. *p* is a metal cylinder, which carries the paper. *q* is a small metal bar for holding the paper on the cylinder. It is hinged to the lower edge of the cylinder, and caught by a spring at its upper edge. It lies in a hollow in the cylinder, so that its outer surface does not project above it. When a new paper is to be put on, the spring catch at the upper end of *q* is raised, *q* pulled out, the old paper removed, and the edges of the new one placed under *q*. It is then pushed down, its upper end is caught by the spring, and the paper is securely held. *r* is a catch for stopping the movement of the clockwork. *s* and *s'* are two weights to drive the clockwork. *t* is a rack for winding up the weight *s'*. *u* is a pendulum, with a movable bob, to regulate the motion of the clockwork and cylinder. By moving the bob up or down, the motion may be made quicker or slower. *v* is a pencil stuck through a piece of cork, and fastened to the upright *m*, so as to draw a line on the paper at the same level as *g*, when there is no pressure on the mercury in the tube. The blood-pressure is estimated by the height of the curve traced by *g*, above the zero line thus drawn. *y* is one of Marey's tympana, which is supported on a movable rod *z*, and may be used for registering either the respiration or the form of the pulse-wave. It consists of a shallow cup of metal, over whose top a piece of India-rubber is tightly stretched. A metal tube passes into the interior of the cup, and a light lever lies over the upper surface of the India-rubber, and is firmly connected with it. When air is blown into the interior of the cup, the India-rubber bulges and raises the lever; when air is sucked out, it becomes depressed and draws the lever down. When used to register the respirations, it is simply connected with a tube in the trachea of the animal, or with a mask fitted before its nose. As the piece of India-rubber stretched over *y* is thin, it would be blown out, and perhaps burst, by the pressure, if we were to connect it directly with the artery. One of Marey's sphygmoscopes is, therefore, introduced between them, when we wish to measure the blood-pressure. The sphygmoscope consists of a little bag of strong India-rubber, enclosed in a piece of glass tubing, connected with the tympanum. The bag is filled with soda solution, and connected with the artery. Each time that the pressure rises in the artery, the bag becomes distended, and forces some of the air out of the glass tube into the tympanum, and raises the lever; and when the pressure diminishes, the bag collapses again, and the lever falls. *x* is a modification of this, designed by my friend Dr. Burdon Sanderson. Instead of a bag enclosed in a tube, it consists of a metal box, across the interior of which a septum of strong India-rubber is stretched. One side of the box is filled with soda solution, and connected with the artery; the other with air, and connected with the tympanum. *w* is a piece of lead tubing for connecting the sphygmoscope *x* with the tube in the artery.

B is a forked tube of German silver or brass for connecting the artery with the kymographion. *a* is a cannula, which is inserted into an artery (see fig. 3A); *b* is a small ring soldered to it, by which it may be tied to the rings *c* on *B*, to prevent it from slipping off; *e* and *e'* are two rings soldered to *B*. By means of ligatures passed through these, *B* may be fastened to the skin or hair of the animal to prevent its being displaced by any sudden movement. The oblique limb of *B* may be connected to *A* alone by a piece of India-rubber tubing, or to both *A* and *w* at the same time by means of a Y glass tube and India-rubber tubing. Another piece of India-rubber tubing is attached to the straight limb *d*, and closed by a clamp or clip. When a clot forms, the clip is taken off, and the clot removed, the tube washed out by a stream of soda solution, and the clip again replaced.

C is the tracing-pen (see fig. 3B). It is stuck horizontally through a piece of cork; another small piece of glass tubing, about three-fourths of an inch long, closed at its upper end, and about one-twelfth of an inch in diameter, or just wide enough to admit the end of the swimmer, is stuck vertically into the same piece of cork.

on a wooden frame (*j*), and caused to revolve at a steady rate by clockwork and pendulum (*l* and *u*). The manometer is fixed to the wooden frame and connected with the artery by tubing of lead and India-rubber. On the mercury in one limb floats a rod or swimmer of glass, to whose upper end is attached a glass pen (*g*), which registers the movements of the mercury on the revolving cylinder.

The disadvantage of the mercurial manometer is, that it does not give the true form or extent of the variations of blood-pressure, the inertia of the mercury causing it to oscillate above and below the true value. We may, however, obtain the true form of each oscillation along with the mean pressure by connecting the artery at the same time with the manometer and one of Marey's sphygmoscopes and levers (fig. 6, *x* and *y*) by means of a Y-tube, one end of which is connected to *d* and the other to *w*. In order to obtain the mean pressure we turn the stop-cock (*e*), till on blowing through it only a slow rise and fall of the mercury can be produced, but no sudden oscillation. On then connecting it with the artery the mercurial column shows the mean pressure, while the sphygmoscopic lever registers each oscillation.

Besides this form there are various others on the same principle, some of which have cylinders which wind off a continuous roll of paper from a bobbin, so that a tracing may be taken uninterruptedly for an hour or two without renewing the paper. In order to avoid the inconveniences of the mercurial manometer, Fick has constructed one (Fig. 8) in which the pressure is not measured by the movements of a column of mercury, but by those of a bent hollow tube (*A*) fixed at one end and free at the other. The tube is filled with alcohol, and its fixed end

connected with an artery. At every rise of pressure this tube tends to straighten itself, and this motion of the free end is communicated by it to a lever (*F*) and writing-point (*G*), which records it on a smoked cylinder.

The advantage of this form of kymographion is, that it gives the exact form, duration, and extent, of each pressure-variation. Its disadvantage is, that the tracings it gives are on a small scale, so that it is not so well adapted for showing small oscillations of pressure like those at each heart-beat in the rabbit, although it answers admirably

Fig. 8.

Fick's spring kymographion. *A* is a flat tube of German silver, fixed at one end *B*, to a piece of board *D*. The other end *C* is freely movable. *E* is a tube connecting *A* with the artery. *F* is a lever made of reed, connected to *C*. *G* is the writing point, moved up and down by *F*, and kept perpendicular by another short lever above. The tube *A* is filled with alcohol, and the tube *E* with a soda solution; and *B* is then connected with the artery. Whenever the pressure rises, the tube *A* tends to straighten itself, but it is firmly fixed at the end *B*, and so the end *C* alone moves upwards, and pushes up the lever *F* and the writing point *G*. Whenever the pressure relaxes, the tube bends back again to its original shape, and the point *G* consequently again descends. The tracing is taken by allowing *G* to rest against a revolving cylinder, covered with a piece of paper, which has been smoked either over a gas flame or a paraffin lamp.

for dogs. Another disadvantage is, that the tracing must be taken on smoked paper, and this is more troublesome to manage than white paper and ink.

MODE OF USING THE KYMOGRAPHION.—The kymographion must first be rendered perfectly level by the screws, *K K* (fig. 7). The upper part of the outer tube of *a* and the tube *c*, the India-rubber tube connecting it with *B*, and *B* itself, are then filled with soda solution and the clip at *e* put on. A fresh sheet of paper is put on *p*, the pen (*g*) filled with ink, and the pencil (*v*) adjusted at the same level. A piece of cotton-thread should be drawn through the pen, so that the end projects just beyond the pen's point; this makes the pen write better. The animal is next fixed, a vein exposed for injecting, the cannula (*a*) introduced into an artery in the way already described, the blood being prevented from entering the cannula by a clip placed on the artery. A drop of carbonate of soda solution is placed in the cannula (*a*), the tube (*B*) fitted into it and tied to it by a thread through the ears, *b* and *c*. Two other threads through *e* and *e'* fasten the tube (*B*) to the skin or hair of the animal. The flask (*f*) is raised several feet above the apparatus, and the clip at *e* opened, so as to make the pressure in the manometer and tubes nearly equal to that of the blood in the vessels so as to prevent the blood from filling the tubes. It must not be greater, or the carbonate of soda will pass into the vessels and produce convulsions. The clip at *e* is then replaced and that on the artery removed, the cylinder set in motion, and a tracing of the normal blood-pressure taken.

The drug in solution is now injected into a vein and a fresh tracing taken. At the time the injection is begun a cross should be made on the tracing opposite the pen of the kymographion, and a *o* should be made when the injection is finished. The time at which these were made should be noted on a separate piece of paper, and afterwards copied on to the tracing itself. Instead of putting each time on a fresh piece of paper, two or three may often be taken on one paper by having two or three exactly similar glass pens of the form shown filled with inks of different colours. Each is stuck through a small piece of cork, and into the under side of the cork a small glass tube is put, which will just fit the top of the swimmer. By simply dropping the

glass tube on the end of the swimmer the pen is in its place at once, and can be changed with great facility. The pen is made to write much better by a piece of thread pushed through it and then cut off, so that it merely projects beyond the point like a very fine brush. A small sable brush may also be substituted for the glass pen.

After the experiment has gone on for some little time, a clot is apt to form in the cannula. When this is the case the clip must be replaced on the artery, the stopcock (*d*) turned transversely, so as to keep the mercury at the same height, the clip on the India-rubber tube of *d* B and at *e* A removed, and the tube washed out by a stream of carbonate of soda. Any clot in the cannula is removed by a spill of twisted paper, by a hog's bristle, or by a piece of whalebone. These whalebone-probes are most convenient, as they can be made of any size. A single jet of blood should now be allowed to escape from the artery, so as to make sure that there is no clot in it, the tube again washed out with carbonate of soda, the clips at *e* B and *e* A replaced, that on the artery removed, and the stopcock turned and tracings taken as before.

REDUCTION OF THE KYMOGRAPHION TRACINGS.—It is not only impossible to publish the tracings as they are taken from the kymographion for the benefit of others, but it is extremely difficult to draw any except very general conclusions from them for one's self. Before they can be of much use they must be reduced to tables, or, what is still better, the tables themselves may be graphically represented. In making the tables we must first fix the time at which the different parts of the tracing were made. The time when the tracing was begun and when the injection was made must be noted down at the time in a separate note-book, or, still better, on the tracing itself. In the first tracing it is convenient to take the time when the injection was made, as a starting-point from which to reckon the other periods.

Beginning at this point, then, we divide the abscissa or zero line into parts corresponding to five seconds each, or any other period we think convenient. If the circumference of the cylinder be sixty millimetres, and it revolve once in a minute, each five millimetres of paper will correspond to five seconds' revolution.

Secondly, we must ascertain the blood-pressure at different times. At the point where the injection took place, we draw from the tracing a perpendicular to the abscissa, and another, five, ten, or fifteen seconds further back. The mean pressure is most readily and exactly got by means of a planimeter; but, as this is an expensive instrument and possessed by few, we usually employ ruder methods. The first is to determine the square superficies of the irregular figure contained by the abscisse, the two perpendiculars, and the curve, and then divide it by the length of the abscissa: this gives the mean height of the pressure-curve. The size of the figure is ascertained by placing over it a piece of tracing-paper or glass ruled in square millimetres, and counting the number of squares contained in it. Volkmann cuts the figure exactly out in paper of uniform texture and weighs it. By then comparing its weight with that of a square of given size, the superficies of the figure is easily ascertained. The second method is still simpler, and, though not so exact, takes much less time, and is, therefore, frequently employed. It consists in drawing a straight line from one perpendicular to the other along the curve, so as to cut the pulse- and respiration-waves as nearly as possible in their middle, and leave as much of their surface above as below it. We then measure the height of this line above the abscissa, double it, and subtract from it the fraction of the whole, which represents the column of carbonate or bicarbonate of soda solution which entered one limb of the manometer and pressed on the mercury in it as the mercury rose in the other limb. For a solution of carbonate of specific gravity 1018, this fraction will be about $\frac{1}{37}$ of the whole.

Passing along the curve taken after the drug has been injected, we note the place where any change in pressure has occurred, and here we draw another perpendicular and proceed as before. Thirdly, we obtain the number of pulsations and respirations in a minute by counting the pulse- and respiration-waves between each two perpendiculars, and reckoning from the time between them what the rate of pulse or respiration will be in a minute. As the rate of both may change several times in a minute, and a calculation of this sort would lead to considerable error, we not unfrequently take fifteen seconds as the unit of time instead of a minute.

The way in which the numbers thus obtained may be tabulated, is shown by the following examples of supposititious experiments. These examples have been made by piecing together several experiments of Von Bezold, and show generally the action of atropine, but must not be regarded as accurate descriptions of any one experiment. Even when a continuous roll of paper is employed, instead of several separate pieces, it is often convenient to divide it by lines, and tabulate each part separately, just as when separate pieces of paper are used.

MODE OF RECORDING EXPERIMENTS.

Experiment I, November 5, 18 .

Young rabbit. Weight 1540 grammes. Jugular vein exposed and one cubic centimetre of tincture of opium, containing two grammes in twenty-five cubic centimetres, injected into it. Cannula in the left carotid. Animal otherwise uninjured.

	Time after injection.	Blood-pressure.	Pulse in 15s.	Respiration in 15s.	REMARKS.
TRACING I.					
Tracing begun 2.39. P.M.	..	78	60	23	$2\frac{1}{2}$ milligrammes of sulphate of atropine, dissolved in 2 cubic centimetres of water, injected into the jugular vein towards the heart.
Injection begun 2.39.15.	..	78	60	23	
„ ended 2.39.25.	..	80	63	18	
At 2.39.35	10s.	83	65	19	
At 2.40.0	35s.	87	70	20	
TRACING II.					
At 2.40.30	1.5	92	92	22	

Experiment II, November 9, 18 .

Old rabbit. Weight, 1764 grammes. Jugular vein exposed. Animal not narcotised. Cannula in the left carotid. Animal otherwise uninjured.

	Time after injection.	Blood-pressure.	Pulse in 15s.	Respiration in 15s.	REMARKS.
TRACING I.					
Tracing begun 3.50.0 P.M. . .	..	92	64	26	² centigrammes of sulphate of atropine, dissolved in 2 cubic centimetres of water, injected into the jugular vein towards the heart.
Injection begun 3.50.10.	..	92	64	26	
At 3.50.13	..	73	..	..	
Injection ended 3.53.15.	..	73	70	24	
At 3.51.0	45s.	72	70	26	
TRACING II.					
At 3.58.0	7.45	78	68	25	

GRAPHIC METHOD OF REPRESENTING EXPERIMENTS.—In looking over a column of figures such as the tables we have now obtained, it is by no means easy to see at once what it really indicates; and it is still more difficult when we have to compare several tables together. For this reason it is of great advantage to convert the tables into curves, from which the result of any experiment can be learned at a glance, and the points of resemblance, or difference in the results of a whole series compared with the greatest ease.

To obtain these graphic curves, we reverse the process by which we formed our tables. We first take a piece of paper ruled in squares, and on it we draw a horizontal line or abscissa, and then a perpendicular

Fig. 9.

lar to one or both ends, and number the spaces along both the abscissa and the perpendicular or ordinate. Those along the abscissa represent periods of time to which we may assign any value which is convenient, seconds, minutes, hours, or multiples of these. The numbers along

the ordinate may represent blood-pressure, pulse-rate, number of respirations, or degrees of temperature; and we may describe curves representing all of these on the same paper, distinguishing them from one another by the use of different coloured inks. Fig. 9 represents graphically the tables of blood-pressure and pulse-rate in Experiments I and II. We begin the pressure-curve by making a dot on the first perpendicular, at a height corresponding to the number 78. Passing along horizontally from this for a space corresponding to fifteen seconds to the abscissa, we make another dot; and at ten seconds further, at a height corresponding to 80, we make a third dot, and so on. We then connect the dots by lines, and thus obtain the curves we wish.

OBSERVATIONS ON THE TREATMENT OF SOME FORMS OF MENORRHAGIA.

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THERE is probably not any one symptom of uterine disease of more frequent occurrence, none certainly of greater gravity, or one causing more alarm to the patient, than menorrhagia. It depends, too, for its origin on such a great variety of causes, not only local, but also constitutional, that the exercise of great caution is necessary on the part of the physician, both as to diagnosis and to treatment; and if he fail to bring to the consideration of the case a perfect knowledge of the conditions capable of giving origin to this symptom, he will certainly meet with numerous disappointments in his practice. The subject, however, of menorrhagia in all its forms would be too extensive for the scope of such a communication as the present one; and I therefore propose to confine myself to the consideration of the treatment most suitable to cases of menorrhagia when occurring in connection with, or dependent on, subinvolution of the uterus, on granular ulceration of the cervix, or on an unhealthy condition of the mucous membrane lining the body of the uterus.

Defective involution of the uterus after labour or abortion occupies a prominent place among the causes giving rise to excessive menstruation. That this should be the case is but natural; for not only is there, when subinvolution exists, an undue amount of blood present in the organ, but also the relaxed condition of the uterine tissue favours its exudation, and therefore, when the periodic determination of blood to the uterus takes place, as it occurs at each menstrual period, the moderate flow which should relieve that congestion becomes a profuse discharge, and often an exhausting drain. But the mischief resulting from subinvolution does not end here, for that abnormal state of the uterus predisposes to that unhealthy condition known as "granular ulceration" of the os and cervix uteri: a condition in which the mucous membrane of the canal of the cervix is hypertrophied, becomes exceedingly vascular, and is often everted to a considerable extent: a condition which increases the previously existing tendency to hæmorrhage. Thus, in not a few cases do we find the two causes present in the same patient. The following case affords a well-marked instance of this.

Mrs. F., aged 48, the mother of twelve children, presented herself among the extern patients of the Adelaide Hospital nearly a year ago. She stated that ever since the date of her last confinement, five years since, menstruation had gradually become more profuse, the flow continuing for a longer time than usual, the intervals between the periods being correspondingly shortened. During the intervals she suffered much from profuse leucorrhœa, and, as a result of this nearly incessant drain, became greatly debilitated. On examining the uterus, the sound passed to the depth of three inches and a half. The os uteri was patulous; there was extensive ulceration of the os uteri; and on separating the lips, the mucous membrane lining the cervical canal was seen to be thickened and highly vascular. This was a case requiring energetic treatment, which I did not dare to attempt so long as she continued to follow her ordinary occupations; and, for a time, she refused to come into Hospital. But, finally, her condition becoming much worse, she consented to do so. My first step after her admission was to introduce several lengths of sea-tangle bougies through the os internum, with the view of being able to explore the cavity of the uterus, and to make the necessary applications to the entire extent of the cervix uteri. This proceeding having enabled me to decide that there was not any polypus or fibrous tumour in the uterus, I cauterised the entire of the inner surface of the uterus freely with the strong nitric acid; this did not cause any pain. She was, however, as a precaution, kept in bed for three or four days. On examining her after the lapse of a week, the condition of the ulceration which existed round the lips of

the os was found to have improved considerably, and she was discharged in a short time perfectly cured.

In the foregoing case, subinvolution was manifestly the primary cause of the menorrhagia, the ulceration being altogether secondary. But in many cases, subinvolution exists alone, or, on the other hand, ulceration may exist alone, either condition being fully sufficient to give origin to severe menorrhagia. As an instance of the former, the following serves as an example. F. L., aged 24, married about a year, was a delicate young woman of lymphatic temperament. Menstruation had always been profuse, especially if she took walking exercise, or exerted herself during the flow. She became pregnant after the occurrence of the second menstrual period following her marriage, but, having imprudently taken a long and fatiguing walk, she aborted at about the eighth week; the two subsequent menstrual periods were so profuse as to reduce her to a state of extreme debility. Ergot, gallic acid, etc., failed to do good. On examining her after the termination of these periods, the uterus proved to be considerably elongated, the sound passing to the depth of three inches and a half; there did not exist any ulceration. The history of the case being altogether against the supposition of the existence of polypus, I came to the conclusion that the menorrhagia depended on subinvolution; in fact, that the uterus had never regained its normal size and tone since the miscarriage, which had occurred two months previously. I therefore decided on carrying out a plan of treatment, the value of which I have repeatedly tested: I mean the introduction up to the fundus of the uterus of ten grains of the solid nitrate of silver, and leaving it to dissolve there. This I accordingly did. The application produced considerable pain, which lasted five or six hours, but no further unpleasant results followed. I confined this patient to bed for several days, but then allowed her to go about. Menstruation appeared at the regular time, and was moderate in quantity; and she became pregnant immediately afterwards.

I wish to call attention specially to this case; first, as illustrating the occurrence of subinvolution as a result of abortion—a fact which is overlooked by many; next, as showing the dangerous menorrhagia which may depend on this condition of the uterus; and, thirdly, as proving the excellent results which follow the treatment adopted. Ergot, gallic acid, and, indeed, all other medicines will frequently fail to check menorrhagia depending on subinvolution; and we must have recourse to treatment directed to the uterus itself; we must stimulate the organ to set up that healthy action by which it regains its normal size after pregnancy has terminated—a process to which Sir J. Simpson has applied the term "involution." With this view, I unhesitatingly advocate the adoption of the treatment practised in the preceding case. I know no other so efficacious.

The mode of carrying it out is simple. The instrument known as Sir Jas. Simpson's "*uterine porte caustique*" is introduced into the uterus just as an ordinary uterine sound. This little instrument consists of a hollow silver tube, in size and shape closely resembling a sound; it contains a flexible stilette, which it fits accurately. As soon as its point is found to have reached the fundus of the uterus, the stilette is withdrawn, and through the instrument is pushed up, by means of the stilette, a piece of solid nitrate of silver reduced to the requisite size and weight, till it is fairly lodged in the cavity of the uterus. In doing this, there is but one caution requisite to be attended to; namely, that as soon as the piece of nitrate of silver has reached the extremity of the *porte caustique*, and before it is finally pushed out of the instrument—a point of which we can always be certain by observing how much of the stilette remains still uninserted—the instrument should be withdrawn to the extent of about half an inch; for if this precaution be not observed, it is possible that the nitrate of silver might be forced into the substance of the uterine wall, instead of being left free in its cavity, an accident which, though possible, is very unlikely to occur. I have dwelt at some length on this plan of treatment, because I am satisfied that its value is far from being appreciated. It is looked upon by many practitioners as heroic and dangerous. I believe, and I have practised it for several years, that it is simple and safe. I do not say that it is always sufficient, and that a cure must always result; but in my hands it has been productive of marked success, and in no single instance have I known of its producing serious symptoms. The application of solid nitrate of silver to the interior of the uterus is by no means a novel practice. Dr. Evory Kennedy used to introduce it into the cavity of the body of the womb by means of an ordinary female catheter several years ago, but he did not leave it there to dissolve. To Sir J. Simpson we are indebted for the further development of the practice, and for the invention of the *porte caustique*. Dr. Kidd, I think, was the first of the Irish obstetricians who adopted his practice.

Menorrhagia resulting from ulceration of the os and cervix uteri is also of frequent occurrence. Mere abrasion of the lips of the os uteri is not sufficient to produce menorrhagia; but that unhealthy, spongy