Section of Obstetrics and Gynaecology.

President—Mr. T. G. STEVENS, F.R.C.S.

Diagnostic Value and Therapeutic Application of Per-uterine Insufflation of the Fallopian Tubes in Cases of Sterility.

By I. C. RUBIN, M.D., F.A.C.S. (New York).

I. DIAGNOSTIC VALUE OF PER-UTERINE TUBAL INSUFFLATION.

PER-UTERINE tubal insufflation was devised for the specific purpose of determining the patency of the Fallopian tubes. In order to answer this question in cases of sterility one was obliged, before this method was available, to resort to exploratory laparotomy. For, in the majority of instances, normal tubes are not palpable *per vaginam* and diseased tubes are so often implicated with diseased ovaries that they are indistinguishable by vaginal touch. In many cases in which the tubal factor was not ascertained, operative procedures to relieve sterility could only fail in their object. Thus, all the otherwise technically excellent operations upon the cervix, not associated with an abdominal section, were futile in the presence of closed Fallopian tubes. Such an experience was all too commonly encountered, to the chagrin of the surgeon, and, what is more important, to the disappointment of the patient.

In 1914 I first attempted to arrive at a non-operative method for determining tubal patency by experiments on animals. Collargol was injected into the uterus and through the uterus into the tubes. Roentgenograms were then made and the shadowgraphs of the uterus and tubes were studied. It was soon seen that outlines of the tube lumen could be demonstrated. Cary appears to have been the first to try this method clinically. My own experience with per-uterine injection of collargol, and of thorium-bromide and iodide solutions, was not favourable. The peritoneal reactions in the patent tube cases were disagreeable. When collargol was employed, inspissation in the tube lumen persisted for some time,—an unhappy sequel in cases in which the tubes were open. In instances of non-patency, however, no harm could result to the patient.

In gas, used instead of opaque solutions, there was at once found the long-sought simple means of determining patency of the tubes. As the method developed it also proved of diagnostic aid in demonstrating non-patency. The method of per-uterine tubal insufflation, or tubal perfusion through the uterus, was begun in November, 1919, at Mount Sinai Hospital, New York. The first clinical application was crude, but effective. Oxygen was allowed to pass into the peritoneal cavity of a patient who came to the clinic for the relief of sterility. The abdomen was observed closely until it was seen to rise; the patient complained of distension and epigastric pain, and, when she stood up, experienced severe pain in the shoulders and in the diaphragmatic region. The X-ray plates showed very definitely a general pneumoperitoneum. The quantity of the gas introduced into the peritoneal cavity of this first patient was estimated at about two litres.

This first experiment at once taught the necessity for: (1) reducing the amount of gas injected; (2) some manometric control; (3) some means of measuring the volume of gas to be insufflated. Accordingly there were adapted the siphon volumeter and a mercury or spring-type manometer. It was soon found that a

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diminutive pneumoperitoneum under the diaphragm [1] (subphrenic pneumoperitoneum) was as easily demonstrable by fluoroscopy as the large-sized pneumoperitoneum by the X-ray plate. This was a definite improvement because of its clinical applicability in ambulatory cases. Another change was made by substituting carbon dioxide for oxygen. Carbon dioxide gas is very rapidly absorbed from the peritoneal cavity. When the amount used is 150 c.c. or less, phrenic irritation and shoulder pains are only momentary. By combining these factors, per-uterine tubal insufflation became an office procedure. The test requires one or two minutes to carry out completely and within from five to ten minutes the patient is ready to leave the office and able to go about her affairs.

The apparatus consists of: a tank containing 100 gallons of carbon dioxide under one thousand pounds, pressure; a reducing gauge; a siphon meter of the type employed in chlorinating water; a manometer (mercury or spring type); rubber tubing connecting the tank through volumeter and manometer to a metal cannula (Keyes-Ultzmann type), fenestrated at its tip; a rubber "acorn" (urethral tip) so fitted over the cannula as to allow the tip to enter well into the uterine cavity while the "acorn" itself engages the external os and thus prevents premature regurgitation of the gas along the cervical canal; a needle valve between the volumeter and the cannula. In most nulliparæ the "acorn" is not important; but in cases of relative sterility in which the external os is much dilated through cervical lacerations this rubber "urethral" tip is of great importance in order to make complete air-tightness possible.

TECHNIQUE.

After the genital canal has been painted with tincture of iodine, as in preparing for a surgical procedure, a speculum exposes the cervix. The anterior lip of the cervix is grasped with a tenaculum. Gas is released from the tank and its displacement of the water in the siphon meter is noted; this must not exceed in rate three pulsations per minute. I have found that a time-ratio-flow of 15 seconds to raise the mercury column to 100 mm. is the most favourable rate of introduction of the gas into the uterus. It may be slower, i.e., it may require a longer time to raise the mercury column to 100 mm., e.g., 20-25 or 30 seconds, but it should never be less than 15 seconds.

The uniform rate-flow of 15 seconds to 100 mm. of mercury serves as a standard of comparison when several insufflations are necessary for the same patient. The data obtained are then more readily interpreted. We have thus learned, for example, to distinguish normally patent tubes from hopelessly closed tubes and from stenosed tubes that are amenable to treatment.

Having predetermined this uniform rate-flow of the gas, the cannula is inserted into the uterine cavity to a point just below the fundus, but well beyond the internal os. The pressure at the cannula tip at the time of introduction into the uterus is zero. This is accomplished by turning the needle valve until it is well open, and shutting it tight as soon as one is ready to allow the gas to pass through into the uterus. This moment is synchronous with the beginning of the pulsation in the volumeter, i.e., when the air is seen to approach the bottom of the U-tube in the siphon. That is easily controlled by the operator, and he counts the number of pulsations in order to calculate the total amount of gas he wishes to introduce.

For the average patient two pulsations are sufficient to establish a subphrenic pneumoperitoneum and its associated clinical manifestations. Each pulsation represents 30 to 40 c.c. of gas, as the case may be. The capacity of the glass siphon can be standardized for 30 c.c. or 40 c.c. In obese patients from three to five pulsations may be necessary. The quantity is seldom in excess of 200 c.c.

The manometer is observed in order to determine the point at which the pressure drops. This initial pressure-drop indicates the point at which the gas is released

through the tubes into the peritoneal cavity. In open tubes this is usually under 100 mm. Hg. When the tubes are closed the initial drop is not noted and the pressure rises steadily to 200. At this moment the valve at the tank should be shut and observation of the behaviour of the mercury manometer should be noted for a few seconds. The cannula and tenaculum are then withdrawn from the uterus. A scant drop or two of blood may be seen to escape from the external os, but this is of no significance. The slight ooze from the anterior lip of the cervix caused by the tenaculum is readily controlled by a cotton tampon which is to be left in for an hour or two. Careful notice is taken of the character and location of the pains produced by the injection of the gas through the uterus, for this point has definite diagnostic importance.

The patient rises from the examining table and is at once fluoroscoped. If the tubes are patent it will be possible to demonstrate with uniform regularity the presence of a single- or double-sided subphrenic pneumoperitoneum. If this be appreciable the patient will voluntarily state that she has pains in one or both shoulders. This latter symptom depends on the one hand upon the amount of gas introduced, and on the other hand upon the sensitiveness of the patient. Hyper-sensitive patients will notice the shoulder pains at once; phlegmatic patients may not notice them at all, or only upon being directly questioned regarding them. Sometimes the pains are experienced after the lapse of a few minutes. In general, less gas is required to evoke this symptom in thin than in obese individuals. When troublesome, the shoulder pains may be made to disappear instantly by the patient assuming the knee-chest posture. All patients feel well enough to dress and leave the office within a few minutes after the test.

(Dr. Rubin then described his apparatus and technique.)

INTERPRETATION OF DATA.

(1) *Normal Tubes*.—The mercury rises to 40, 60, 80 or even 100 mm. and drops 10 to 40 points, fluctuating several times until the cannula is withdrawn. Usually the patient complains of slight pains referable to the uterus, which are sometimes described as similar to "unwell pains." Pain on the side is seldom experienced. The fluctuations in pressure are due to tubal peristalsis.

(2) *Closed Tubes*.—If one tube is closed or stenosed and the other normally open, the patient will complain of pain on the side of the tubal obstruction. If both tubes are stenosed or closed the pain is bilateral. This pain is due to distension of the tubes proximal to the point of obstruction, and it is present whenever the latter is situated at any point beyond the isthmus.

When the manometer rises to 200 mm. Hg, and uterine colic or mid-line pain referable to the suprasymphyseal area is complained of, but no complaint of pain on either side is made, the closure is located at the intramural portion of the tubes or very near the isthmus of each side.

I have found these observations to be practically pathognomonic of the site of obstruction; and I have not had to resort to the injection of opaque solutions into the uterus for this determination.

SPASM OF THE TUBES.

There are instances in which, after a relatively high pressure is reached, a drop will be noted, indicating that a small amount of gas escapes through a minute opening. As far as my observations have gone they point to the intramural portion and the fimbriated end of the tubes as the site of predilection for spasm. Studying this question with the aid of sodium bromide and sodium iodide injections into the uterus, Kennedy [2] maintains that he has been able to demonstrate isthmospasm. Meaker [3] appears to have indisputably demonstrated tubal spasm, by making X-ray pictures during injection of CO₂ gas and after half an hour's interval. During

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the gas injection he was able to show a distended tube; this distension was not visible half an hour later.

Recently, I have attempted to study, by means of the kymograph, the behaviour of the uterus and tubes during insufflation. The results are interesting and promise to throw light on tubal physiology in the human species. So far, they tend to corroborate the findings of Dr. Snyder and Mr. Seckinger, of the Carnegie Institute in Washington, D.C. These authors studied the rhythmic contractions of the freshly removed uterus and tubes from patients at the Johns Hopkins Hospital. From the same laboratory, of which George L. Streeter is the director, Ferdinand C. Lee [4] reports some interesting observations bearing upon this question. He injected indian ink into the cornu of the uterus directed toward the Fallopian tube. The cat used in the experiment was not in the oestral period, the uterus being small and the ovaries showing no large follicles. He found

"that the ink would pass into the tubes but under great difficulty, a pressure of 280 mm. of mercury being frequently necessary in repeated experiments." "On the other hand, in the same animal, injections into the isthmus of the tube and directed towards the cornu passed easily into the uterus. However, when the uterus was large and swollen and when relatively large follicles appeared in the ovary, then the passage from the tube was easy. Experiments along the same lines on the dog and guinea-pig have so far indicated the same general phenomenon."

"The recent report of Rubin on the various pressures necessary for trans-uterine insufflation of the tubes at various stages in the intermenstrual period of the same individual is in harmony with the general principle obtained from work on the lower mammals. It is believed that the uterine end of the tube, through its varying degrees of patency, is to a great extent responsible for the differences in pressure he obtained. Furthermore, the material examined thus far indicates that the greater patency occurs about the period of ovulation, probably a little before that time."

EVIDENCES OF TUBE SPASM.

The high pressure required to overcome an organic obstruction or stenosis may be distinguished from that due to a tube spasm, by application of the following technique: The cannula is to be held inside the uterus after the gas has been shut off. If a drop of the mercury is noted, and if this is not due to regurgitation from the cervical canal, it indicates a possible tubal spasm or the overcoming of an exceedingly narrow opening at some portion of the tube. Radiographic examination may demonstrate distension of the tube in instances in which the stenosis is near the fimbria or at the ampullary portion. Vaginal palpation immediately after the insufflation may demonstrate the distended tube; a few minutes later it becomes impalpable. Auscultation over the lower lateral abdominal areas—a step in the technique as first suggested by Henderson and Amos [5]—may distinguish the high-pitched note of stenosis from a lower-pitched note elicited on the normal side. The fluoroscopic examination or Roentgen film must show the presence of gas under the diaphragm. In favourable cases the distended tube may also be demonstrated, as Meaker [3] has shown. Differential point: if the gas on a second examination enters the peritoneal cavity freely, and at a lower pressure, it may be safe to assume that the Fallopian tube in that particular case was in spasm at the first insufflation. That this point must be of clinical importance, especially in instances of sterility, goes without saying. Further study with the kymograph may help to establish peculiarities in genital function that have hitherto escaped attention.

SIMPLIFIED METHODS.

It must be obvious that any method which does not offer the possibility of studying the question of tubal patency as outlined above must fail in eliciting important data. The most important factor is the uniform pressure-rate flow and volumetric control. All methods depending upon hand pressure, as when the syringe

or rubber bulb is employed, cannot possibly offer the even flow that can be obtained from a gas tank with an accurate release valve. There are a number of other disadvantages of simplified methods which, for lack of time, I shall not enter into. There is only one further point which it may not be amiss to emphasize in this connexion. Simplified methods of uterine insufflation have encouraged careless employment of the tubal patency test and may perhaps be responsible for disaster in some cases. This does not appear to have been adequately appreciated and I believe the factor of uniform pressure-rate flow to be of prime importance for the scientific and safe application of per-uterine tubal insufflation.

CONTRA-INDICATIONS AND DANGERS.

The original method of per-uterine or "trans-uterine" tubal insufflation, as it was first termed by Peterson [5A], is apparently simple enough. It should be carried out in accordance with the rules that careful experiment and established experience have indicated. The patient must present none of the cardinal contra-indications. There must be no evidence of pelvic or genital suppuration, no pelvic tenderness, no inflammatory masses, no fever; nor must the patient be menstruating or bleeding from other causes at the time of insufflation. She must not be a patient who is suffering from serious cardiac, renal, pulmonary or great general metabolic disturbances. These latter conditions clearly forbid any but imperative diagnostic manipulations. As they arise in individuals who, in general, form poor subjects for pregnancy and labour, there would seem to be no need for, or value in, subjecting them to the test of tubal patency for diagnosis and therapy.

The dangers incidental to the method may be briefly summarized as due to: (1) misemployment of the procedure without due regard for the rigid rules of the technique; (2) an unfavourable time with regard to the menstrual cycle; (3) ill-chosen cases.

It may be said that where the test has been used most extensively and adequately—the cases aggregating thousands—no untoward results have been noted. Peterson and Cron, Ward, Aldridge, Meaker, Rongy, Hirst, Hunner, Bonney, and many others besides myself, have seen no bad effects. However, two fatalities have been reported to me as occurring in New York City, both of them inexcusable. A very careful inquiry into the circumstances of these deaths showed that the operator in each case violated the rules of technique, besides improperly selecting the case. In one case death was due to shock induced by a terrific injection of the gas in a woman aged forty-two, a quadripara suffering from cardio-renal disease. In the other case death was due to embolism, an excessive amount of gas under great pressure being introduced into the genitals of a patient suffering from multiple fibroids and bilateral pyosalpinx; forcible dilatation of an amputated cervix preceded and curettage followed the insufflation.

The danger from embolism in properly selected cases can be dismissed from consideration if the test is done correctly.

The only possible untoward effects may arise in those infrequent instances of chronic tubal suppuration in which the fimbriated end is still patent. As the pus, even in these cases, is usually innocuous, the danger from spilling into the peritoneal cavity will not be appreciable. Absence of tenderness on bimanual examination, and absence of reaction, may be taken as an assurance that the insufflation will not be followed by serious sequelæ. In doubtful cases the sedimentation test and observations on the behaviour of the temperature for twenty-four hours following the vaginal examination help to diagnose the presence of latent or subacute pelvic inflammation.

CHOICE OF TIME.

The most favourable time to carry out per-uterine tubal insufflation is from four to seven days after the cessation of a menstrual flow. During this time the endometrium is flat, the uterine ostia of the tubes are not obstructed by the swollen

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endometrium obtaining in the pre-menstrual phase, and there is less apt to be bleeding. Moreover, it is the safest time, in that it will not interfere with a possibly impregnated ovum. Insemination soon after a post-menstrual insufflation will give the best chance for the spermatozoa to reach the tubes, where they may await and impregnate the ovum. Since adopting this rule I have noted a greater incidence of pregnancy.

REPETITION OF THE TEST.

Cases in which the tubes are demonstrated to be normally patent do not require a repetition of the test. If a subphrenic pneumoperitoneum is not produced the first time, however, it is well to repeat the insufflation after an interval of a month. Several trials may be made during the one examination, but it is preferable to defer the second trial. Three or four tests at the same relative date from successive regular menstrual periods have been carried out. A fifth or sixth trial can do no harm where the patient is anxious for a therapeutic result. Several of my patients, proved to have tubal patency on a fourth test and subsequently, gave birth to normal children. The second and third tests were done for corroboration of the original findings and for the purpose of formulating a more reliable prognosis. The indication for a plastic operation upon the tubes may at the same time be clearly established.

EFFECT ON THE NEXT MENSTRUAL PERIOD.

The next menstrual period is sometimes ushered in two or three days early. Peterson and Cron [6] have called attention to the relief of dysmenorrhœa in some cases and I have noted this in quite a number. Slight staining follows the insufflation for a day or two in a fair proportion of the cases, but it needs no special attention.

II. THERAPEUTIC APPLICATION OF PER-UTERINE TUBAL INSUFFLATION.

From the very outset the method was obviously seen to be one that might possess therapeutic as well as diagnostic value. Some authors appreciated this possibility and called attention to it. Peterson and Cron were the first to publish a paper on the therapeutic value of trans-uterine gas inflation [6]. I must say that although in this respect personal observations were accumulating, it was not until this past May (1925) that I was able to report at the meeting of the New York State Medical Association upon ninety-five cases of pregnancies out of a series of 1,000 consecutive insufflations. My chief interest until then was focused upon developing per-uterine tubal insufflation as a diagnostic procedure.

Peterson and Cron state that "a number of patients examined for sterility by the Rubin test where the gas had been forced through the tubes, reported that pregnancy had followed without change of other conditions present during the time they had been desirous of children. This led us to send follow-up letters to all women in whom gas had been successfully forced through the tubes, omitting, naturally, those cases where our investigations had shown that the husbands were the cause of sterility." . . . "at varying periods following the Rubin test thirteen, or slightly more than one third of those women, became pregnant."

Thirty-six out of forty-seven women written to replied to their questionnaire.

"Thirty women had never been pregnant. Six women had conceived earlier in their married lives. Since four of the six women who were relatively sterile became pregnant after the passage of gas through the tubes, while nine of the thirty who were absolutely sterile conceived after gas inflation, it follows that something more than the mere passage of the gas and mechanical opening of the tubes must be considered in trying to explain the reason for the higher per cent. of pregnancies in those women who had previously conceived."

"Pregnancies in ten went to full term. Three resulted in spontaneous abortion at the third month. The younger the woman the greater will her chance of conceiving be. All but three became pregnant within six months after inflation (ten cases.) Five had only one

normal period. The shorter the period of sterility, the more quickly pregnancy supervened. None of the cases who conceived were operated on after the inflation and no treatment was instituted."

The analysis of the cases of pregnancy following per-uterine tubal insufflation made by these pioneers with this method has formed a basis for comparison with my own experience. In my series of 1,000 consecutive private patients seeking relief from sterility, ninety-five became pregnant following tubal perflation. These patients reported this fact voluntarily, no systematic questionnaire having been sent out. As no complete survey of this series has been made, the future may show the proportion of successful cases to be greater than 9.5 per cent.

There can be no doubt that introducing gas through the uterus and tubes into the peritoneal cavity does help certain women to conceive. The literature contains definite statements in this respect. Rongy was among the first to make special mention of pregnancy following the use of uterine insufflation and reported four pregnancies out of 152 cases examined by that method [7]. Besides Peterson and Cron's cases, S. R. Meaker [8] reports three cases of women married and sterile for two, four and ten years respectively, in whom pregnancy followed promptly upon the trans-uterine insufflation of gas. Two became pregnant immediately, and the third became pregnant two months after the test. In each case considerable difficulty was encountered in forcing gas through the tubes. This was accomplished in the first attempt in two cases and at the fourth attempt in the third case. Meaker urges that insufflation should be tried as a routine therapeutic measure in all cases in which every factor apart from the tubes has been excluded. In another publication Meaker has collected forty cases, including his own three, of pregnancy following trans-uterine insufflation. R. Cron [9] in discussing Henderson's and Amos's article, states that of fifty-eight patients to whom he had sent questionnaires, fourteen reported pregnancy. The majority became pregnant after one or two months, some after a second inflation. Incidentally, dysmenorrhœa was relieved in some cases also.

Heinrich Guthmann [10] reports that of fifteen patients in whom per-uterine insufflation was carried out three became pregnant soon after the test. He draws no conclusions.

P. H. Charbonnet [11] reports the case of a woman with a normal menstrual history, married six years without becoming pregnant. Pelvic examination was negative. The gas pressure rose to 200 mm. Hg; a second attempt resulted in the gas pressure rising to 180 mm. Hg, and suddenly dropping to 130 and 100 mm. Hg. One hundred and twenty c.c. of gas were used. She missed the following period and was four months pregnant at the time of his report.

Aldridge [12] reports 600 cases examined by per-uterine insufflation. Nine patients who were insufflated became pregnant. Other cases may have occurred but no systematic inquiry had been made.

One woman who had been married four years without conceiving required a maximum pressure of 250 mm. Hg at two trials. She became pregnant soon after the third test, which required 180 mm. Hg. Another woman aged 32, married eight years, had undergone a resection of the right tube and removal of a right parovarian cyst. On September 21, 1921, she was insufflated, the maximum pressure reaching 120 mm. Hg. On January 10, 1923, she was found to be four months pregnant.

A third case was that of a woman of 30, married eight years, with one child 7 years old, who became pregnant after the period following insufflation, the maximum pressure being 178 mm. Hg. Another woman of 26, married eight years, with one full-term 7-years old child, underwent a plastic operation upon her cervix uteri, resection of the left tube, and an operation for retroversion (Simpson), June 26, 1920. Uterine insufflation with maximum pressure of 190 mm. Hg was performed (date not given). On September 20, 1922, she was five and a half months pregnant.

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A patient of 22, married six years, with one full-term 5-year-old child, underwent uterine insufflation December 7, 1922, the maximum pressure being 160 mm. Hg. On January 26, 1923, she was dilated and curetted. At her last examination in the follow-up (no date given) she was eight months pregnant.

Hirst and Mayer [13] report three cases in women

"who became pregnant so soon after the Rubin test that we are disinclined to view this phenomenon as incidental."

In their first case, a woman of 30, married eight years, who had had a dilatation and curettage for the relief of sterility four years before, on December 12, 1921, underwent a per-uterine insufflation and the pressure rose to 150 mm. Hg. Patency of the tubes was proved by the fluoroscope. On February 3, 1922, she was found pregnant.

A second case was that of a woman aged 26, married seven years and never pregnant. Dilatation and curettage one year after marriage. The pelvic examination was negative. By the insufflation test performed October 4, 1921, the Fallopian tubes were found to be patent. In January, 1922, she missed her menstrual period and proved to be pregnant.

The third case was that of a woman aged 27, married three years. Dilatation and curettage eighteen months after marriage, the uterus being then retroverted. Per-uterine insufflation, December 27, 1921, indicated non-patency. Before the test was to have been repeated she had missed her period and examination later revealed an undoubted pregnancy.

I have had several cases similar to this last-mentioned one of Hirst and Mayer and feel that in these particular instances uterine insufflation exerts a therapeutic influence.

Ottow (Dorpat) [14] believes that as a therapeutic measure the procedure is dangerous in the hands of the general practitioner, because of the possibility of its lighting up a gonorrhœal infection. With this view there can be little disagreement, except that the careful general practitioner who has acquired the technique of uterine insufflation may safely add this to his general diagnostic armamentarium.

The incidence of pregnancies following the use of per-uterine tubal insufflation is greater than the published reports would tend to show.

In November, 1923, I sent out questionnaires to individual operators and clinics using the "trans-uterine" insufflation apparatus made by E. Machlett and Son according to my design. Fifty-eight replies were received, thirty-five of which contained more or less complete data and twenty-three gave scanty data because the method had been but too recently used by the respondents. Of the thirty-five returned questionnaires containing data, twenty-four gave figures with respect to pregnancy following trans-uterine tubal insufflation. There were fifty-two pregnancies out of a total of 763 patients treated for sterility by the method of uterine insufflation.

These reports from the published and unpublished records are but a few of those which by now must have reached a substantial number. From these alone several conclusions may be drawn as to the therapeutic value of per-uterine tubal insufflation. The cases were properly chosen and serve to illustrate the type that may be benefited by the insufflation. The greater number of the women were married four or more years, and the sterility must in all probability have been due to some obstruction in the tubes, because of the initial high pressure. (Cases reported by Hirst, Mayer, Aldridge, Charbonnet, Meaker, and Mandelstamm.)

Particularly may the test be said to be of therapeutic value when a woman, sterile for a period of five years or more, becomes pregnant the month following a per-uterine insufflation. This therapeutic result may also be ascribed to the test even though two months elapse before pregnancy ensues. If other measures had been tried without avail the insufflation procedure may be presumed to have exercised a therapeutic effect. When the maximum pressure is not in excess of 100 mm. Hg and pregnancy soon follows it may be a mere coincidence. However,

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Of the cases of relative sterility there were:—

One child sterility	11
„ and one miscarriage	4
„ and two spontaneous miscarriages	2
One stillbirth	2
Two children by a first marriage	1
One or more spontaneous miscarriages	12
One or more induced abortions	5
Ectopic gestation	2
	—
	39
Married one year and under	14
„ between one and two years	32
„ „ two and three years	15
„ „ three and four years	7
„ „ four and five years	11
„ „ five and six years	5
„ „ six and seven years	4
„ „ seven and eight years	5
„ „ eight and nine years	3
„ eleven years	2
„ fifteen years	2
„ but number of years unknown	1
	—
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In 61 cases the marriage was between one and three years.

In two cases the marriage was under a year—in one case three months and the other one six months.

In 18 cases the marriage was between three and five years.

In 21 cases the marriage was between five and fifteen years.

HOW DOES PER-UTERINE INSUFFLATION AID THE STERILE WOMAN?

(1) By establishing patency of the genital tract from the external os to the abdominal opening of the Fallopian tubes. Any cervical canal that is patulous to the uterine cannula used in the uterine insufflation is ample for the entrance of spermatozoa. If the external os appears punctate or pin-point but admits the cannula, this is proof that it is wide enough to allow semen to enter the cervical canal. The cannula at the same time stretches it somewhat, rendering it more patent for a varying period of time. Should coitus take place shortly after this procedure the spermatozoa must have a better opportunity than otherwise of effecting an ascent in the uterine cavity.

(2) In some cases a mucous plug not visible at the external os, but occupying the deeper portion of the cervical canal, is seen to be expelled after the insufflation and on withdrawal of the uterine cannula. I have the impression that the removal of this mucous plug in this manner may be the important factor in some of the successful cases.

(3) By separating mild agglutinations of the folds of the tubal mucosa, by straightening out tortuous tubes, especially of the infantile type, by dislodging a mucous inspissation from a narrow to a wider portion of the tube, by actually separating adhesions at the fimbriated end in cases requiring 150 to 200 mm. Hg or more, a way is opened for the descending ovum to meet the ascending spermatozoa.

(4) Still another factor, not to be lost sight of, is the psychic impression which per-uterine insufflation makes on the patient. Although the exact nervous mechanism is not at present clear, there are women who respond to the physical stimulation of per-uterine insufflation through the psyche acting upon the autonomic genital apparatus. The question as to whether it induces a certain amount of relaxation in otherwise spastic tubes, the uterine openings of which are practically closed, must await further inquiry. That there actually exists, in certain tubes, spasm sufficient to close the uterine ostium in a manner similar to the closure of the internal os of the uterus, has been recently demonstrated. I have been able to convince myself of

the presence of spasm in a fair number of cases and believe that it is very common in the premenstrual or pregravid state and less common in the postmenstrual interval. Overcoming such spasm may be supposed to exert a therapeutic influence at least in some cases.

INDICATIONS FOR PER-UTERINE INSUFFLATION.

(1) Primary sterility, where contributing causes, including those for which the husband might be responsible, have been eliminated, and some operative procedure is contemplated. Here it has a definite prognostic as well as diagnostic value.

(2) Primary sterility in which the patient is known to have passed through a gonorrhœal pelvic infection soon after marriage and is at the time of the inquiry free from pelvic symptoms.

(3) Sterility following a pelvic exudate or abscess complicating a puerperium or abortion, with or without the history of an operation and where resolution has apparently taken place.

(4) Primary sterility in which the patient had peritonitis of appendicular origin in the premarital or postmarital state, to exclude tubal occlusion by peritoneal adhesions.

(5) One-child sterility without the definite history of pelvic infection.

(6) After one whole tube and part of another have been removed for hydrosalpinx or pyosalpinx (conservative surgery).

(7) After unilateral ectopic pregnancy, to determine the patency of the residual tube.

(8) After salpingostomy, to determine the success of the operation which was calculated to effect an opening of occluded tubes.

(9) After sterilization by tube ligation, to test the patency of the tied or severed tubes.

(10) After multiple myomectomy in nulliparæ, to make certain that at least the uterine ostium of the tube has been left intact.

(11) Sterility of long standing, where pelvic masses are palpable and clinically diagnosed as fibroids or "chronic disease of the adnexa." The test shows whether or not the tubes are open.

(12) As a therapeutic measure, to eliminate the tubal factor in sterility.

The causes of sterility are too often obscure. It appears that at least the mechanical factor of patency should be possible of determination in most cases. The method of inflating the uterus with carbon dioxide gas, with the production of an artificial pneumoperitoneum, obviates the necessity for surgical exploration and is especially serviceable in the obscure cases.

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Discussion.—Dr. T. W. EDEN said he had been interested in the question of tests for patency of the tubes, and had, in a number of cases, used the apparatus introduced into this country by Currier, of New York. He had employed it solely as a method of diagnosis, and he did not know that therapeutic effects were claimed for it, until listening to Dr. Rubin's paper. He thought that an extensive use of the apparatus, by a number of different observers, should be made before acceptance of the view that the passage of gas through the uterus and tubes could clear away non-organic obstructions which were the cause of sterility. At the same time, we know so little of the causes of sterility that a simple method of treatment, such as insufflation, would be heartily welcomed if experience should prove that it was efficacious. He agreed with the author of the paper in the view that a complete block could be registered by this instrument even when the tubes were patent. He had recently had two such cases, both having been operated upon immediately after the test was made. In one case the block was apparently due to kinking of the tube from retroversion, in the other the only morbid condition found was a small interstitial fibroid in the fundus, which might have so distorted the uterine cavity as to prevent the gas from entering the tubes, even under considerable pressure.

Mr. S. FORSDIKE said that inflation of the uterus and tubes had become a routine in the diagnostic investigation of sterility in the female, and the question at issue was, which was the best technique? Dr. Rubin, with some justification, considered that his apparatus was the best, condemning the syringe and bulb methods on account of possible fallacies due to a faulty bulb or leaking valve. These objections must be brushed aside, for it must be assumed that an investigator would only use apparatus which gave him constant and reliable results. He (Mr. Forsdike) had been using the bulb method for some time and had found it sufficiently reliable to justify him in continuing with it, considering its simplicity. In approximately 5 per cent. of cases air failed to pass through the tubes where it was found that they were patent on subsequent examination with lipiodol. One case was worthy of mention: that of a woman with a completely retroverted uterus; when the abdomen had been opened the uterus was found to be lying turned back in the pouch of Douglas. The uterine tube, with bulb attached, had been previously introduced. Inflation up to 200 mm. mercury filled the uterus, but no air passed through the tubes; on the uterus being lifted forward into the anteverted position air passed freely through one tube.

The greatest drawback to Dr. Rubin's method was that he relied upon the X-ray diagnosis of pneumoperitoneum. Under the application of his (Mr. Forsdike's) method, when the patient was in the Trendelenburg position, and the vagina filled with saline solution to indicate any escape of air, the pubic area formed the dome of the abdomen and the diagnosis was

established by auscultation over the abdominal ostia, where the air bubbles could be heard escaping, and by percussion over the suprapubic area where an increasing area of tympanites proved the presence of the pneumoperitoneum.

A further point he wished to make was that inflation alone was insufficient; it was necessary to carry the investigation further by means of opaque bodies, for if inflation was negative, nothing was known as to the site of obstruction, and this knowledge was essential to the ultimate decision as to whether an abdominal operation was justifiable. Most surgeons would agree that any operation upon the proximal end of the tube, with the object of restoring the lumen, was doomed to failure, whereas there was some prospect of success if the fimbriæ only required unfolding and the ovary placing in the lumen. The opaque body he had used was lipiodol, and this he used only after experimenting upon a series of cats in order to ascertain whether it had any ill-effect upon the peritoneum or the epithelium of the tubes. In no case was any adverse effect produced either macro- or microscopically, and this had been borne out in his subsequent work on the human female. Dr. Rubin disdained the investigation by opaque bodies on the ground that he was able to decide the seat of obstruction by the area in which the patient complained of pain, i.e., centrally or laterally. He (the speaker) hoped that Dr. Rubin would correct this impression by trying a series of cases with opaque bodies.

Mr. VICTOR BONNEY said that he desired to pay the highest tribute to Dr. Rubin's work, which constituted one of the greatest advances in gynæcology of recent years. He had already described the apparatus he had himself been using,¹ which had the advantage of being simpler than that devised by Dr. Rubin. That it was efficient he had proved on many occasions by opening the abdomen with the inflator *in situ*. One of the most important things that inflation had taught us was the futility of a large proportion of the salpingostomies performed before Dr. Rubin's discovery. He was perfectly certain in his own practice that in nine out of ten cases the tubes had remained blocked at the uterine end of the tube in spite of the new abdominal ostium. A new set of statistics would have to be prepared, dealing with the cases operated upon since inflation was practised as part of the operation. He was interested in hearing that Dr. Rubin had found what he himself had discovered, namely, that retroflexion in certain cases caused tubal occlusion by kinkage.

In regard to carrying out inflation in the consulting room he doubted very much whether it would ever come into vogue in this country. The majority of women here would not submit to any operative procedure without an anæsthetic; moreover, it increased the danger, as Dr. Rubin had pointed out, of the proceeding being carried out by relatively unskilled practitioners amidst unfavourable surroundings.

He had heard that very afternoon of a patient whose tubes he had inflated fourteen months ago, and, finding them closed, restored their patency by an abdominal operation, with the result that she was now four months pregnant. This lady owed her happiness to Dr. Rubin.

Mr. ALECK BOURNE said that he had been using the form of apparatus which was demonstrated to the Gynæcological Section of the British Medical Association, at Portsmouth, in 1923, by Dr. Gilman Carrier, of New York, and that he had been very much pleased with the results obtained by its use. He (Mr. Bourne) would like to know if it was necessary to obtain proof of the entrance of gas into the peritoneal cavity by X-ray examination, or was it not sufficient to watch the gas pass into the uterus from the volumeter, and corroborate this evidence by stethoscopic indications heard over the hypogastrium? It seemed that in routine practice the use of X-rays was a serious disadvantage, and if proof of successful insufflation could be obtained by simpler means than radiography, the use of the apparatus would have a much wider scope.

¹ *Lancet*, November 22, 1924, p. 1062.

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Lastly, he asked whether there was any difficulty in preventing back leakage around the rubber "acorn" in cases of laceration of the cervix. It appeared that the unevenness of the cervical circumference might easily give rise to defects in close co-action of the rubber "acorn" and external os.